Comparative Agricultural Geography of East Pakistan and Louisiana.

Fazle Karim Khan
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COMPARATIVE AGRICULTURAL

GEOGRAPHY OF EAST PAKISTAN AND LOUISIANA

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Geography

by

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B.A. (Hons.), Patna University, 1943
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August, 1958
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ABSTRACT

East Pakistan and Louisiana exhibit marked physical similarities but have conspicuous cultural contrasts. Physically, both areas have Tertiary hills, Pleistocene terraces, Recent flood plains and numerous rivers. Extensive flood plains and Pleistocene terraces in both localities are potentially great agricultural regions. The latitudinal position of the two areas are similar but East Pakistan lies in the path of tropical monsoonal storms. As a result of its geographical position and because of the migration of the equatorial trough northward in the summer East Pakistan has heavy summer rain and dry frostless winters. Louisiana experiences winter cyclonic storms and summer tropical storms. Rainfall is evenly distributed throughout the year and frosts and cold winters are common.

In two areas with so many physical parallels it might be assumed that agricultural practices would also be similar. However, cultural heritages of the two areas are vastly different and they are the determining factors in the contrasting agricultural landscape.

Culturally, East Pakistan is an oriental country predominantly inhabited by Muslims and Hindus. It is a densely populated land with traditions deeply rooted in the past. Louisiana is primarily inhabited by Christians of European extraction. Historically, it is a new land and has not had time to develop a strong inherited culture. Compared with East Pakistan, it is sparsely settled.

Although the New World Revolution spread to East Pakistan by the
British, its influence on rural farming practices was negligible. The Pakistan farmer uses the same primitive implements used in the area for centuries. Generations of inheritance rights have divided and subdivided the land into small parcels that average 2.07 acres per farmer. The full effects of the Agricultural Revolution are noticeable in Louisiana agriculture. Farms are large (average size 72.2 acres) and are primarily mechanized.

The value systems of the two areas dictates the types of crops grown and farming practices in both regions. Dibble and plow farming is practiced on a subsistence basis in East Pakistan. Vegetables and grains are basic ingredients in man's diet both because of taboos against eating meat and because the heavily populated land will produce more vegetable food per acre than will animal pasture land. Rice, pulses and oilseeds are important staple foods and supply the largest per cent of protein and fat needed in the diet.

The Louisiana farmer grows commercial crops on a large scale. Irrigation, which is insignificant in East Pakistan, is an important element in the agricultural practices of the state. Animals, grown for meat and dairy products, are one of the chief income sources on Louisiana farms. Farming methods have advanced with changing and improving technology in all phases of human life. Unlike his Pakistani counterpart, he is not of necessity tied to a few acres of land and is not so greatly influenced by ties with the past.

East Pakistan field work for this study was conducted during a five-year period. Detailed surveys of numerous villages were made.
Louisiana field work was carried on for one year and different types of farms and farm practices were studied.
INTRODUCTION

There are many similarities between the physical landscapes of East Pakistan and Louisiana. Both have extensive areas of Recent flood plains, Pleistocene terraces and Tertiary hills. Although the two areas exhibit marked parallelism in physical characteristics, they differ greatly in the ways that man has altered his physical surroundings. Agriculture has been important to man in both Louisiana and East Pakistan since the Stone Age. The shape, size, and location of fields, methods of cultivation and crops planted by man are expressions of his impact on the natural landscape. Different patterns of living between the two areas are indicative of different cultural heritages.

The problem in this study is to compare the agricultural patterns of the two areas and to interpret them in the light of physical and cultural factors. Man's agricultural activities are governed largely by two aspects of his culture: his technical development and his system of values. How man uses the potentialities of his milieu depends upon his technology and this in turn is an outgrowth of the economic, political and religious systems under which he lives. In this study an attempt is made to explain how the differences between the technical development and cultural heritage of East Pakistan and Louisiana have developed into different agricultural landscapes of the two areas.

East Pakistan lies roughly between 21° and 27° North latitude and 88° and 93° East longitude. It has an area of 54,111 square miles and a population of 122 millions (1951). Before the creation of Pakistan in 1947, the province of East Pakistan formed a part of the province of Bengal.
It is divided into 17 districts of various sizes for administrative purposes. The largest district, I'ymensingh, has an area of 6,230 square miles, and the smallest, Kushtia, has an area of 1,371 square miles. Districts are composed of from one to five subdivisions. There are 55 subdivisions in all. East subdivision is divided into a number of areas called police stations. In all there are 110 police stations in East Pakistan. Aside from the village, the smallest administrative unit is the union which is a division of the police station. Agricultural statistics are collected at the police station level and published on a district basis. Through the courtesy of the Director of Agriculture, the author was able to obtain statistics for some years on a subdivisional basis.

Louisiana lies approximately between 29° and 33° North latitude and 89° and 94° West longitude. It has an area of 48,523 square miles and a population of 2.7 millions (1950). For administrative purposes, the state is divided into 64 parishes which are comparable to the districts of East Pakistan. Agricultural statistics are available on a parish basis.

For this study, field work in East Pakistan was conducted during a five year period. Detailed surveys of a number of villages were made. Some of the surveys were part of the Pilot Project on Land Use Studies of Dacca District conducted by the Department of Geography, Dacca University, and sponsored by the Cultural Affairs Council, Inc., New York. The surveys were made by using cadastral maps on a scale of sixteen inches to a mile. They were in accordance with the procedure laid down by the World Land Use Survey and Land Utilization Survey of Great Britain. Detailed information was gathered on crops, livestock, agricultural...
practices and man's cultural patterns.

Louisiana field work was done in several selected areas on a reconnaissance basis. Different types of farms were visited and studied. Rice farms located in Lafayette and Ascension Parishes, and abandoned rice farms along the Mississippi River below New Orleans and along Bayou du Large were included in the study. Sugar farms along the Mississippi River and Bayou Lafourche, cotton farms in West Feliciana Parish, truck farms in Tangipahoa and Livingston Parishes and south of New Orleans along the Mississippi River and orange gardens in Plaquemines Parish were studied. Surveys were made of the Kleinpeter dairy farm and of cattle farms along the Mississippi River south of Baton Rouge. Reconnaissance visits were also made in coastal marshes and cheniers, the prairie region, the Florida Parishes, the Red River Valley and the Tensas River area.
PHYSIOGRAPHY

East Pakistan and Louisiana exhibit a marked parallelism in geologic history and resulting physiographic characteristics. Each has been the scene of tremendous alluvial deposition since the Mesozoic era. In the Recent epoch alluviation, subsidence, and isotatic uplift have taken place and the rivers in the two areas have built large flood plains and deltas. East Pakistan and Louisiana both have Tertiary hills, Pleistocene terraces, and Recent plains (Plate I). Within this broad physiographic similarity, they differ appreciably in detail.

EAST PAKISTAN

The major part of East Pakistan is an alluvial basin (the Bengal Basin) filled with Quaternary sediments deposited by the Ganges, Brahmaputra, Meghna, and other streams (Plate I A). The time from mid-Miocene to the end of the Tertiary was a period of crustal unrest in the Indo-Pakistan subcontinent. Major earth movements culminated in uplift of the Himalayan Mountain Range, the faulted and folded hills and plateaus of Assam, and the more gently folded Chittagong Hills of East Pakistan (Plate 2 A) (Wadia, 1953, pp. 304-308).

The Pleistocene epoch is notable for continental ice sheets which extended in the northern hemisphere as far south as 39° N. latitude (Ibid, p. 373). The Bengal Basin lying to the south of this line did not experience glaciation but could not escape its world-wide effects. During the glacial periods the sea level fell with the advancing continental ice sheets; only to rise again during the interglacial periods.
EAST PAKISTAN
PHYSIOGRAPHIC REGIONS
(AFTER MORGAN & McINTIRE)
The generally accepted estimate of the drop in sea level during the last glacial age is on the order of 400 feet (Russell, 1957, p. 379). Lowering of sea level increased stream gradients and caused them to become entrenched. During interglacial stages the glaciers melted and with resulting rise of sea level river gradients decreased and deposition took place in their entrenched valleys. Four interglacial alluviations are represented by four Pleistocene terraces along the Gulf coast of the United States (Fisk, 1939). Pleistocene terraces have also been recognized in the Bengal Basin in several areas (Plate IA). Factual data about them are inadequate, however, and do not conclusively prove the existence of multiple terraces (Morgan and McIntire, 1956, p. 38).

East Pakistan can be divided into three major physiographic units; Tertiary Hills, Pleistocene Terraces, and Recent Plains (Plate IA). These can be further subdivided into specific areas:

**Tertiary Hills**
- Chittagong Hills
- Tripura Hills

**Pleistocene Terraces**
- Barind
- Madhupur Jungle
- Minor Terraces

**Recent Plains**
- Tippera Surface
- Piedmont Alluvial Plain
- Ganges-Brahmaputra-Meghna Flood Plain
- Deltaic Plain (including the Tidal Plain)
- Chittagong Coastal Plain
Tertiary Hills

The Tertiary Hills of East Pakistan are a continuation of the Assam hills and the Burmese arc. Political boundaries have divided the hills among three countries, Burma, India, and Pakistan. Hills within Pakistan occur in the Northeastern and Southeastern part of the country.

Chittagong Hills

The Chittagong Hills occupy the District of Chittagong Hill Tracts and parts of Chittagong District (Plate IA). This is the only extensive hill area in East Pakistan. They rise from 200 to 3,000 feet within a distance of forty-five miles from west to east. The steep gradient coupled with over 100 inches of rainfall annually, falling mostly within four months, has deeply entrenched the streams draining the hill slopes. Principal drainage follows synclinal valleys paralleling the hill ranges for considerable distance before finding their way west into the Bay of Bengal. The jagged hills are unfit for cultivation and it is only in narrow stream valleys that agriculture is possible. Some parts of the hill slopes are, however, used for growing crops by the primitive tribes living in the area who practice shifting cultivation, locally called 'jhuming.' The major parts of Pakistan's hills are clothed with forests.

Tripura Hills

Only a few northern spurs of the Tripura Hills are in East Pakistan so they do not form a continuous chain. They are represented by a series of isolated and elongated hills occupying the southern part of Sylhet District (Fig. 1). Although the hills are too rugged for extensive farming, the area is suitable for tea cultivation. The majority of Pakistan's tea plantations are located in this region.
Pleistocene Terraces

Pleistocene terraces of East Pakistan generally stand above the monsonal flood level and are drained by relatively small, entrenched meandering streams. Their higher relief is due not only to the more resistant nature of the materials, but also to the uplift to which they have been subjected (Ibid., pp. 11-15). In East Pakistan there are two large areas of Pleistocene terraces and a number of minor ones (Plate I A).

Barind

The Barind is the largest of the Pleistocene terraces in the Bengal Basin, covering an area of about 3,600 square miles (Ibid., p. 19). It has been separated into four units by the Recent flood plains of several rivers draining the foothills of the Himalaya. Of these the three eastern units occupy the west-central part of East Pakistan (Plate I A).

The surface of the Barind has a domal appearance and rises twenty to forty feet above the adjacent Recent flood plains. Small streams, locally called 'kharis,' have entrenched meandering courses that are easily distinguished from the sluggish and braiding rivers of the flood plain (Ibid., pp. 19-26).

Madhupur Jungle

South of the Old Brahmaputra River is the Madhupur Jungle (Plate I A). It covers an area of about 1,585 square miles and is the second largest Pleistocene terrace in East Pakistan. The Madhupur Jungle has an elevation of twenty feet on its eastern and southern parts and rises to 100 feet on the western side. On the east and south it dips beneath the Recent deposits but on the west toward the Brahmaputra Flood
Plain it presents a highly dissected steep edge formed by a series of six en echelon faults ranging in length from six to thirteen miles (Ibid., p. 27). Streams have thoroughly dissected the Madhupur Jungle and a flat surface is hard to find.

**Minor Terraces**

There are a number of minor Pleistocene terraces in East Pakistan; the Lalmai Hills, a few areas in the southern part of Sylhet District, and Chhatak Hills (Plate I A). The Lalmai Hills cover an area of thirteen square miles in Tippera District west of Comilla. It is an uplifted horst bounded on the east and west sides by faults and tilted toward the east (Ibid., p. 34). This small unit, formed of silts and sands with underlying layers of gravels and coarser materials, has an average elevation of seventy feet with individual peaks rising over 150 feet. The hills are highly dissected, particularly on the eastern side.

The Sylhet Hills and Chhatak Hills lie in Sylhet District. The former extend northeast from the town of Sylhet (Plate I A) and occupy an area of seventy-two square miles. They attain a height of 200 to 300 feet above sea level. The Chhatak Hills occupy a small area of about twenty-five square miles west of Sylhet. Both hill areas have rugged relief, and exhibit a surface thoroughly dissected by steep, narrow stream valleys.

The Barind is by far the most extensive and agriculturally the most important of the Pleistocene terraces. Its slightly dissected and flat-to-rolling surface is suitable for cultivation. The Madhupur Jungle stands next to the Barind in agricultural potentiality.
The best agricultural lands of the latter are toward the south where relief is less and river valleys are wider. The minor terrace outliers are rugged, thoroughly dissected, and less important agriculturally. With the exception of tea gardens the hilly areas are primarily forest.

Recent Plains

Most of the area of East Pakistan is composed of the deltaic and alluvial plains of the Ganges, Brahmaputra, Meghna, and other less important rivers. In contrast to the meandering pattern of the Mississippi River the streams in East Pakistan are braided and invariably overflow their banks during the summer monsoons. Major changes in stream location, depth and width result from annual floods. The lack of permanent meandering river channels has resulted in significant differences in the physiographic characteristics between East Pakistan and Louisiana. Alluvial sediments are distributed over a larger area and levee backslopes are less uniform with flatter gradients in East Pakistan. Lowlands between levee systems are shallow marshlands flooded during the rainy season but may dry up during the winter season. These shallow depressions are locally called "bils". Because of greater inundation, more uniform deposition of sediments and a marked dry season there is practically no backswamp in East Pakistan. Consequently, agriculture can be extended far into the "bils" whereas Louisiana backswamp can not be farmed.

Another significant difference is that the Mississippi enters the Gulf of Mexico through several passes and has built a bird-foot type of delta, whereas, the combined waters of the Ganges, the Brahmaputra, and the Meghna flow into the Bay of Bengal through a seven-mile-wide estuary. The braiding rivers build numerous sandbars in their channels and river mouths of which some are large enough to be inhabited and cultivated.
Tippera Surface

The Tippera surface has low relief land and is inundated during the monsoon flood. It occupies an area of 3,000 square miles and covers most of Tippera District and parts of Noakhali and Sylhet Districts (Fig. 1). It is slightly uplifted and is an older part of the Recent flood plain (Morgan and McIntire, 1956, pp. 39-41). Its average elevation is about nineteen feet above sea level in contrast to fourteen and one-half feet for the adjoining flood plain. The streams have a meandering pattern, rather than the braiding pattern of the streams draining the flood plain to its immediate west. Rivers are slightly entrenched and have formed cut-off and ox-bow lakes. The drainage pattern is rectangular, probably a man-made feature (Idem).

The Piedmont Alluvial Plain

The Piedmont Alluvial Plain comprises the major part of Dinajpur and Rangpur Districts (Fig. 1). It is drained by the Tista, and other streams which rise in the Himalaya Mountains in the north. Coalescing alluvial fans formed by numerous rivers flowing out of the Himalaya Mountain system have built an extensive Piedmont Alluvial Plain (Plate I A) which overlaps the northern part of the Barind Pleistocene surface. Changing river systems on the plain have contributed greatly to the diversity of crops since nothing can be grown in the inundated areas except jute and rice.

Ganges-Brahmaputra-Meghna Flood Plains

Between the Piedmont Alluvial Plain-Shillong Plateau and the northern limits of the Deltaic Plain (Plate I A) are several flood plains. The largest is in the Sylhet Basin area; the remainder lie along the river systems that extend west of the Madhupur Jungle to the Pakistan border.
The Sylhet Basin comprises the major part of Sylhet District and adjoining parts of Mymensingh District (Fig. 1). It is a depressed basin and is probably still subsiding. This is suggested by the much lower elevation of the area (ten feet above sea level in its northern part) compared with the adjoining flood plain of the Old Brahmaputra River. The subsidence has been thirty to forty feet within the last few hundred years and is tectonic in origin. It is related to the main fault system along the southern flank of the Shillong Plateau (Ibid., pp. 41-43). The major part of the Sylhet Basin is under water during the rainy season.

Flood Plains are important agricultural areas of East Pakistan. River levees are intensively cultivated and lands that are submerged during flood times are utilized during the dry winters. Parts of the "bil" areas and sand bars are farmed when the rivers are at low stage.

Deltaic Plain

The combined Ganges and Brahmaputra Rivers have built the Deltaic Plain which extends south of the Barind surface to the Bay of Bengal. Over two-thirds of its total area lies in East Pakistan. Its southern part is affected by high tides and will be considered separately as the Tidal Plain.

Numerous active and inactive distributaries characterize the Deltaic Plain. The inactive rivers west of the Garai-Madhumati carry a small amount of the Ganges load during flood time. In the dry season most of them are completely cut off from the parent stream. These rivers have meandering courses and formed ox-bow lakes during their active stages. (Bagchi, 194, pp. 50-56).

East of the Garai-Madhumati lies the active part of the delta which is annually inundated. The Garai-Madhumati became important after
the diversion of the Old Brahmaputra to the present Jamuna channel (Fig. 1). The Ganges' water was thus blocked and a considerable portion began to flow through Garai-Madhumati (Majumdar, 1942, p. 78).

River levees, "bils" and sandbars are the main physiographic features in the Deltaic Plain. Relatively large but shallow "bils", locally called "jheels" are present in the Khulna, Faridpur and Bakarganj Districts (Rizvi, 1955, p. 207).

Numerous sand bars are present both in the channel and at the mouth of the combined rivers. Some of them have become fairly large in size and have been settled and cultivated.

The coastal area of the Bay of Bengal includes the Tidal Plain. It lies within the southern part of the Khulna and Bakarganj Districts. The major part of the Tidal Plain was formerly covered with mangrove forests. Much forest land has been cleared for agricultural purposes but it still covers an area of 2,316 square miles in the southern part of the Khulna District (Government of East Bengal, 1953, p. 26). The absence of fresh water streams and salinity conditions caused by tidal invasions and accentuated by cyclonic storms prohibits intensive farming. Settled areas must be diked against high tidal water.

Chittagong Coastal Plain

The Chittagong Coast Plain occupies a narrow margin along the sea in Chittagong District. The average width is five to six miles, widening to sixteen miles at the mouth of the Karnafuli River. A narrow strip of coastal marsh has developed and isolated mangrove swamps are present. Inland the usual levee and "bil" topography of the East Pakistan Deltaic Plain is found.
LOUISIANA

The major part of Louisiana occupies a part of the Gulf Coast Geosyncline and was an arm of the sea in early Mesozoic Era. Since then deltaic sedimentation has been building land seaward. Land advance has not been continuous but occurred in three cycles: (1) Upper Jurassic-Lower Cretaceous; (2) Paleocene; and (3) Miocene-Recent (Fisk, 1944, p. 67). During intermediate periods fluvial activity was less significant. These are represented by times of marine invasions. Periods of fluvial activity coincide with uplift inland when resultant steeper gradients permitted the streams to carry heavier sedimentary loads. The Sabine uplift has special significance because it is partly responsible for the hilly character of Northern Louisiana.

Louisiana can be divided into the following physiographic regions (Plate I B).

- Tertiary Hills
- Pleistocene Terraces
  - Older Terraces
  - Younger Terraces
- Recent Plains
  - Red River Alluvial Valley
  - Mississippi Alluvial Valley
- Deltaic Plain
  - Natural Levees
  - Coastal Marshes
  - Marginal Deltaic Plain

**Tertiary Hills**

Tertiary Hills occupy the northwestern part of Louisiana and
are divided into two parts by the Red River which crosses it from northwest to southwest (Fig. 2). Pleistocene remnants are found in many places, particularly in Webster, Red River, Grant and La Salle Parishes (Martin, 1954, p. 13; Murray, 1948, p. 27; Fish, 1938, pp. 52-56).

The Tertiary hill section of Louisiana presents a belted topography of aligned hills and valleys. The belted topography has resulted from differential erosion of resistant and less resistant southward-dipping beds of Tertiary coastal plain sediments. Resistant rocks are usually formed of sandstone and siltstone (Welch, 1942, p. 11) and at places are capped with more-resistant ironstone (Martin, 1954, p. 12). Topography emerges as wolds or cuestas with inland facing escarpments and gentle backslopes. Valleys have been formed from shales, silts, and calcareous sediments. This general topography was complicated by the Sabine and Monroe uplifts and has been accentuated by stream erosion. Discontinuous, sharp-crested ridges, flat-topped hills, ravines, and gullies are typical of the area. The region as a whole has an elevation of over 200 feet while the wolds rise from 300 to 400 feet. The highest peak has an elevation of 535 feet.

Agriculturally the Tertiary hill region of Louisiana is limited. The major part is either covered with forest or is returning to forest. The narrow river valleys and flat terrace remnants are the better agricultural areas.

**Pleistocene Terrace**

Pleistocene history of Louisiana is very similar to that of East Pakistan. In both areas erosion and alluviation took place during the glacial and interglacial stages respectively. In both areas Pleistocene
alluviation is represented by terraces. However, the Louisiana history is known in greater detail. Four Pleistocene terraces have been recognized; from oldest to youngest they are Williana, Bentley, Montgomery, and Prairie (Fisk, 1939, p. 186). Sedimentation in the deltaic area led to subsidence which caused isostatic uplift inland (Russell, 1940, pp. 1228-29). Uplifts have raised older terraces higher inland causing regional tilting so that each terrace surface dips beneath the subsequent one.

**Older Terraces**

Older terraces Williana, Bentley, and Montgomery cover two large sections of Louisiana east and west of the Mississippi Flood Plain (Plate I B). The older terraces east of the Mississippi River occupy the northern part of the Florida Parishes (Fig. 2). The Southern Mississippi Uplift near the Mississippi-Louisiana boundary has not only raised and tilted them but has also increased their stream gradients. Their southern boundary coincides with the 150 foot contour line while the northern parts have an elevation of over 300 feet. The Montgomery terrace has an average slope of eight feet per mile, and the Williana and Bentley terraces have a gradient of twenty-five feet or more (Ibid., p. 1219). As a result the streams are deeply entrenched and have thoroughly dissected the area.

A second area of older terraces lies west of the Mississippi and south of the Tertiary hills. Their average height is about 100 feet, with local relief of some twenty feet. The Montgomery terrace has a gulfward slope of 1.25 feet per mile, the Bentley, five feet, and the Williana eight to ten feet (Jones, 1954, p. 18; Russell, 1940, p. 1213). The Williana terrace is thoroughly dissected and the topography in the
northern part of the region is rugged. In other sections large flat surfaces are available for cultivation, though tillage has not been extensive.

Younger Terraces

The younger terraces include the Prairie terrace and parts of Montgomery terrace. They are the most extensive of the Pleistocene terraces in Louisiana. The largest is in southwestern Louisiana, that dips beneath the coastal marsh. It extends from the Sabine River to Bayou Teche (Fig. 2); its average north to south length is seventy miles. The gulfward slope is one and one-half to two feet per mile (Jones, 1954, p. 17 & 25). Except on main streams, the relief is imperceptible. Numerous circular pimple mounds about five feet high and thirty to fifty feet in diameter break the monotony of the flat surface. After the fields are plowed and leveled the pimple mounds are still recognizable by circular infertile spots.

Another large unit of the younger terrace is north of Lake Pontchartrain (Fig. 2). Its average slope is 1.4 feet per mile south of Baton Rouge for ten miles and then the slope increases to two feet per mile for the next ten miles (Russell, 1940, p. 1218). Its average height is fifty feet above sea level.

Smaller areas of younger terraces are located in eastern Avoyelles, Morehouse, Ouachita and northeastern Rapides Parishes and in parts of the Bastrop Hills in the vicinity of Bastrop (Fig. 2). The first unit is divided into two parts by the Red River which has cut a steep sided valley. The Bastrop Hills are not wholly Pleistocene terrace. Their southern part comprises Recent sediments of the Ouachita River (Fig. 2). They rise like an island in the Mississippi Flood Plain, with an average height of
100 feet above sea level. The eastern edge is a scarp, the western, a gentle slope.

Macon Ridge lying in the northern part of the Mississippi Alluvial Valley, rises twenty feet above the flood plain. It is a steep bluff on the east with a gentle backslope on the west. The ridge is formed primarily of Arkansas River deposits but irregular ridges of Pleistocene deposits called Macon Ridge Island are found within its dissected surface (Fisk, 1944, p. 30).

**Recent Plains**

Broad alluvial valleys which have been formed by the Red and Mississippi Rivers extend from the northern border of Louisiana to a line from Donaldsonville to Franklin (Fig. 2). South of this area is the Deltaic Plain of Coastal Louisiana.

**Red River Alluvial Valley**

The Red River Alluvial valley was formed by the Red River, the main tributary of the Mississippi in Louisiana. Several times in the past it has changed its course; it formerly flowed into the Arkansas River and at one time entered the Gulf of Mexico independently (Fisk, 1944, p. 46).

The Red River valley is five to fifteen miles wide, bordered by steep valley walls. It has shifted position within its valley leaving numerous meander scars. Its levees are better developed on the west bank as the east bank is close to the valley wall. On the west bank the levee varies from one-fourth to three miles in width, while on the east bank its width ranges from zero to two miles. The average height of the levees above the backswamp is ten feet and they are intensively cultivated. Interlevee depressions between natural levees enclose rim
swamps. Lowlands flank the flood plain and abutt against the hill. Marginal basins were created by alluviation across the lower portion of tributary valleys. Interlevee depressions, lowlands and marginal basins are poorly drained areas and are of little agricultural importance (Murray, 1948, pp. 10-13).

**Mississippi Alluvial Valley**

The Mississippi Alluvial Valley in Louisiana is confined within the steep sided valley which was cut through Tertiary hills in the north and Pleistocene terraces in the south. The Mississippi River has meandered across its flood plain during Recent period and has formed the topography within the valley walls. Levee ridges built by it and its various tributaries for the highest aggradational floodplain features. The lowest features in the area are numerous lowlands and basins which are enclosed by natural levees and high lands. The Mississippi meander belt is about ten to twenty miles wide in the north and widens southward to between fifty and seventy-five miles near its southern limit.

**Deltaic Plain**

The Deltaic Plain extends south from the confining limits of the Mississippi Alluvial Valley and gradually widens until it dominates the entire Louisiana Gulf Coast. It can be divided into three physiographic types; natural levee ridges, coastal marshes and the marginal deltaic plain in southwest Louisiana.

Natural levees of several important past and present Mississippi River distributaries are the prominent high ground in this area. Natural levee systems are separated by inter-levee depressions that contain extensive backswamps and lakes. Some of the better agricultural land in the state is located on natural levees of the Mississippi River and its
The Coastal Marsh occupies the area between the western shore of Vermilion Bay and east to the Chandeleur Island Arc (Fig. 2). Most of the marshland stands just above mean tide level. Vast stretches are inundated by strong southerly winds, tropical storms and hurricanes (Russell, 1936, p. 24). Beaches and natural levees are dominant features in this area otherwise devoid of relief. Numerous bays and lakes occupy extensive acreage in the Coastal Marsh.

The Marginal Deltaic Plain extends west of Vermilion Bay and south of the Prairie Terrace. The rivers which traverse the region are too small to build deltas on a subsiding coast (Ibid., 1935, 449). Moreover, they drain into lakes where they deposit their sediments before entering the Gulf. Topographic features are the chenier ridges, which are ancient beaches averaging about ten feet high. Extensive marsh land separates the several stranded beaches.

**SUMMARY**

East Pakistan and Louisiana are built largely of alluvial deposits and exhibit a marked similarity in physiography. East Pakistan rivers are braided streams with wide, multiple, and shallow channels forming numerous sandbars and towheads. They overflow their banks every year and have gently sloping levees leading to shallow marshy lowlands.

The Mississippi is a poised, meandering stream which does not overflow its banks due to flood control measures. It has numerous distributaries extending to the Gulf. Between the natural levees of its deltaic plain are extensive areas of marshland and lakes. Physiographic units of East Pakistan and Louisiana differ in size, topography and agricultural potential. The statistics in Tables I and II summarize the
<table>
<thead>
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<th>Physiographic Units</th>
<th>Total Land</th>
<th>Land in Farms</th>
<th>% of Total Land in Farms</th>
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<tbody>
<tr>
<td>The Tertiary Hills</td>
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<td>East Pakistan: Chittagong Hill Tracts District</td>
<td>3,204,570</td>
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<td>Louisiana: State Economic Area Grant, LaSalle, Winn Caldwell, Jackson, Bienville, Lincoln, Union, Claiborne and Webster Parishes</td>
<td>4,469,760</td>
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<tr>
<td>The Pleistocene Terraces</td>
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<td>East Pakistan: Selected Police Stations</td>
<td>8,054,627</td>
<td>609,952</td>
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<td>Louisiana: Acadia, Jeff Davis and Lafayette Parishes</td>
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<td>Tangipahoa and Washington Parishes</td>
<td>939,520</td>
<td>407,072</td>
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<td>Recent Flood Plains</td>
<td></td>
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<tr>
<td>East Pakistan: Moakhali, Tippera, Dacca Districts</td>
<td>4,396,857</td>
<td>3,711,582</td>
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<td>Louisiana: State Economic Area 2 Concordia, Catahoula, Tensas, Franklin, Richland, Ouachita, Morehouse, Madison, West Carroll and East Carroll Parishes</td>
<td>3,957,760</td>
<td>2,073,554</td>
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<td>Deltaic Plains</td>
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<td>East Pakistan: Khulna and Bakarganj Districts</td>
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<td>Louisiana: State Economic Area 6 West Baton Rouge, Iberville, St. Martin, Iberia, St Mary, Terrebonne, Lafourche, Assumption, St James and Ascension Parishes</td>
<td>4,110,080</td>
<td>1,285,739</td>
<td>31.3</td>
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Source: U. S. Census of Agriculture, 1950, Plot to Plot Enumeration in Bengal, 1945, and data supplied by Director of Agriculture, East Pakistan.
comparisons between the two areas.

**TABLE 2**

**Physiographic Units**

Estimate* of Tertiary Hills, Pleistocene Terraces and Recent Alluvial Valley in East Pakistan and Louisiana

<table>
<thead>
<tr>
<th>Physiographic Feature</th>
<th>East Pakistan (Square Miles)</th>
<th>Louisiana (Square Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tertiary Hills</td>
<td>6,150</td>
<td>12,122</td>
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<tr>
<td>Pleistocene Terraces</td>
<td>4,345</td>
<td>15,441</td>
</tr>
<tr>
<td>Recent Alluvial Valley</td>
<td>43,646</td>
<td>20,960</td>
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*Compiled from various sources.
SOILS

Soils of East Pakistan and Louisiana are derived from the Tertiary rocks, the Pleistocene sediments and the Recent deposits. Both areas are humid; Louisiana has no dry season, whereas East Pakistan has alternate wet and dry seasons. Summers are hot in both areas, but winters are cooler in Louisiana. Fairly high temperatures throughout the year with alternate wet and dry periods, in East Pakistan are very favorable for the chemical weathering processes of leaching, and laterization. In Louisiana conditions are slightly less effective for the aforesaid processes. Forest cover and grasslands are more extensive in Louisiana. In East Pakistan, grasslands, a prominent feature in southwestern Louisiana, is almost unknown. Louisiana coastal areas are primarily covered with marsh vegetation, while mangrove forests are prominent along the coasts in East Pakistan. These physical similarities and differences are reflected in the soils of the two areas.

Recent deposits laid by the Mississippi River system in Louisiana and by the Ganges-Brahmaputra River systems in East Pakistan represent areas of immature alluvial soils. The Pleistocene sediments and the Tertiary rocks have yielded mature soils which have been oxidized and leached to a considerable extent. Oxidation and leaching are more pronounced in the Tertiary areas because of a longer time of development and greater relief. This applies to both East Pakistan and Louisiana. But within these broad similarities there are appreciable differences in detail.
Soils of East Pakistan can be classified on the basis of parent materials, topography and vegetation. The soils derived from the Tertiary hills are laterized and form a distinct group. The Pleistocene terrace sediments lying above the flood level have yielded reddish oxidized soils which are classified as red soils. Deposits of the Recent flood plain have not as yet developed into mature soils, and may be grouped as alluvial. These alluvial soils can be further subdivided on the basis of texture, structure and chemical composition. Swamp soils are a distinctive feature of the coastal mangrove forest area. Thus the following soils may be recognized in East Pakistan (Plate II A).

Hill Soils

Red Soils

Alluvial Soils
- Loamy Sands
  - Sandy loams, silt loams
  - and clay loams
- Clays
- Swamp Soils

Hill Soils

The Hill soils of East Pakistan cover the Chittagong, Tripura, Sylhet, and Chhatak Hills. Their approximate area is 7,147 square miles. These hills have steep gradients and are composed mainly of Tertiary sandstones and shales. Parts of the Sylhet and Chhatak Hills are covered with Pleistocene alluvial sediments. Over 100 inches of rain is received in the hill regions within a year, most of which falls from March to
EAST PAKISTAN

SOILS

Compiled From Various Sources

Miles

Alluvial Soils

Hill Soils

Swamp Soils

Red Soils

Madhupur Jungle

Tripura Hills

Barind

Sylhet

Comilla
LOUISIANA
SOILS
(AFTER STURGIS)

- Hill Soils
- Flatwood Soils
- Prairie Soils
- Terrace and Bluff Soils
- Red River Bottom Soils
- Miss. River Bottom Soils
- Coastal Marsh and Swamp
September. There is a marked dry season from November to February. The average July temperature is over 80° F. and the average January temperature is about 64° F. Hence conditions are favorable for laterization and the laterites are the main soils of these areas (Chatterjee, 1949, p. 15).

Laterites of East Pakistan have ash-gray to red-brown color at the surface and have a red or yellow "B" horizon. They are highly leached clays rich in hydrous oxides. They develop a peculiar granular condition which promotes excellent internal drainage and allows cultivation immediately after rains. But these soils are deficient in exchangeable bases and in available nutrients; therefore fertility level is low (Ukil, Vyar, and Biswanath, 1944, p. 350).

Low productivity of the hill soils coupled with rugged relief has made the hills agriculturally unimportant. Most of the hill soils support dense forests. Low hills in the Sylhet Basin called "teelas," and some hills of the Chittagong District are utilized for tea plantations. Great care is taken to maintain soil fertility and to prevent erosion. The hills are terraced and artificial drains are made to check erosion. In the Chittagong Hill Tracts, shifting cultivation practiced by the hill tribes has accelerated soil erosion. The soils washed from the hills are deposited in the river valleys. Wherever these valleys are wide enough, "aman" (winter) rice is grown.

Red Soils

Red soils are derived from and cover major Pleistocene terraces of East Pakistan: The Barind, the Madhupur Jungle and the Lalma Hills. Their total area is approximately 4,248 square miles. The red soils are locally called "khiar," or "lal mati."
Sesquioxide ratios of the red soils of East Pakistan are below 2.0 and well above 1.33. This is a distinct lateritic characteristic. But the decrease in the silica-alumina ratio in lower horizons and the illuviation of iron in "B" horizons are non-lateritic properties. Hence they should better be classes as red soils rather than lateritic soils. (Government of East Bengal, 1952, pp. 12-13).

Alternate wet and dry periods have helped leaching and oxidation. The amount of oxidation depends upon topography. Comparatively flatter surfaces of the Barind exhibits least oxidation while the Lalmai Hills with maximum relief are most oxidized. On flat lands, the topsoil is brownish-grey and on rough lands greyish-brown or reddish-brown. Lower horizons in both cases are brick red or crimson red mixed with ferruginous concretionary materials. The brownish-grey soils cover the larger part of the Barind and considerable area of the Madhupur Jungle. The greyish-brown or reddish-brown soils are well represented in the Madhupur Jungle (Siddiqui and Mohammed, 1951, p. 245).

The texture of the red soils varies with topography. Surface soil is sandy loam on flat lands and clay loam on rough lands. The texture becomes heavier with increasing depth, but nowhere is a pure clay layer found in the subsoil. Red soils are friable and porous and have a crumbly structure. Tillage is easy in sandy loam areas but becomes difficult in stiff clay loams. The crumbly structure of the soil is being altered by continuous cultivation (Government of East Bengal, 1952, p.16).

Red soils of East Pakistan are deficient in lime, organic matter, and phosphoric acid. Potash content, though higher than the other two contents, is also inadequate. They are very poor in organic matter and highly acid in reaction. The pH varies from 5.5 to 6.0 in the soils.
of the Madhupur Jungle, and from 6.0 to 6.5 in the soils of the Barind (Chaklader, 1946, p. 158, Siddiqui and Mohammed, 1951, p. 245). The deficiency in the above-mentioned essential elements has considerably reduced the soil's productivity. The abundance of iron and alumina oxides has reduced their water-holding capacity, hence they are poor agricultural lands. The choice of crops is limited and the yield is low. Water is inadequate for winter ('rabi') crops. Sugar cane and tobacco crops are limited by nutritional and water deficiencies and the yield of jute is too low to become a major product. Rice is the only crop which is widely cultivated. Its yield is also not comparable to that grown in the flood plain. "Aus" (autumn) rice is grown on higher lands since deep, standing water is injurious. "Aman" rice is grown on lower lands. Small interspersed marshy areas grow "boro" (summer) rice. The marshy areas are reservoirs of organic matter and other plant nutrients washed down from the surrounding lands. They remain filled with water during the summer which makes them unsuitable for agriculture, so they are cultivated only in winter.

Heavy summer rainfall causes erosion on red soil areas which are uncovered during the winter season. Extensive areas have been rendered uncultivable by gully formation and dissection. There is more erosion in the tilted madhupur Jungle than in the Barind region. The surface of the Lalmai Hills is so highly dissected that little agriculture is possible. The growing of legumes would improve conditions considerably. Legumes would not only control erosion, but also reduce nutritional deficiency. An experiment of this nature has recently been started in the cutover pinelands of northwestern Louisiana. Its beneficial effects are already felt. It is a good example for East Pakistani farmers. Contour cultivation
on flatter lands and terracing on steeper slopes can also help check soil erosion.

**Alluvial Soils**

Alluvial soils cover the Recent flood plains of East Pakistan. Their approximate area is 41,250 square miles. These soils are relatively immature as large parts of the flood plains are annually inundated by the rivers. Hence new alluvium is deposited over large areas every year. The character and depth of the alluvium deposited in an area is not necessarily the same year after year. Hence the soil character of the area also changes. A fertile loamy soil may be covered with a new layer of sand within a short period of time or vice versa.

Based on texture, alluvial soils of East Pakistan may be divided into the following groups (Plate II A). (This division, though based upon texture, also reflects physical and/or chemical differences):

- Loamy sands
- Sandy loams, silt loams and clay loams
- Clay
- Swamp Soils

**Loamy Sands**

Loamy sands are the least extensive of the alluvial soils of East Pakistan and generally cover sand bars and towheads ("chars"). Numerous towheads and sand bars of various sizes have developed in the braided channels and at the mouth of the Ganges-Brahmaputra-Meghna Rivers.

The percentage of sands in loamy sands is so high that they are locally called "bali" (sands). In some places, the loamy sands are replaced by pure sands. Usually the materials coarsen with depth. Loamy
sands change to fine sands and then to coarse sands. Sometimes sands predominate from the surface downwards.

Cultivation on towheads and point bars in East Pakistan starts before they are sufficiently high to be cultivated during the flood season. The farmers move in, as soon as the flood water recedes in the fall. Vegetables such as potatoes, onions and garlic, which mature before the arrival of the summer floods, are grown. When the towheads become sufficiently high to be cultivated during the rainy season, jute and "Aus" rice are produced. These soils are deficient in nitrogen, and are often planted with grasses a year or two before growing rice and jute. "Aman" rice is usually grown on the sand bar islands. Jute is not preferred for planting on the sand bars because the soils are too saline.

Sandy loams, silt loams and clay loams

Major areas of the flood plains of East Pakistan are covered with sandy loams, silt loams and clay loams. Their texture depends primarily upon their location with respect to the rivers. The Piedmont Alluvial Plain is covered largely with sandy loams (Siddiqui and Mohammed, 1951, p. 245). Sandy loams and silt loams are commonly found on the levees and back slopes. They are more extensive along the major rivers. The soil texture becomes heavier with distance from the levee crests. On the backslopes the soils are predominantly silt and clay loams, grading into loamy clays and clays in the "bil" areas (Government of East Bengal, 1952, pp. 19-21).

Structure of the levee soils generally varies in accordance with their texture. The sandy loams are generally structureless. The silt loams are either structureless or develop crumbly structure. The clay
loams and loamy clays are crumby or cloddy (Ibid., pp. 18-21). Tillage is, therefore, easy and organic matter present improves the tilth. Roots of jute have difficulty in penetrating soils with cloddy structure. This is one of the reasons why jute is confined to loams and silt loams. Rice plants can, however, be grown successfully in both crumby and cloddy soils. The drainage is usually free except in loamy clays. The color of levee soils varies from light gray to dark gray. Organic matter increases with distance from the levee crests and causes the soils to become progressively darker (Siddiqui and Mohammad, 1951, p. 295 and Beers, 1955, p. 9). Clay pans within a depth of one foot are present in areas of Bakarganj District. They help in production of rice but are unsuitable for sugar cane because their roots are not able to penetrate the pan (Mukherjee and Carbery, 1937, p. 30).

The chemical composition of the levee soils differ from place to place. The Ganges sediments have higher lime content than the Brahmaputra alluvium. The Ganges River receives substantial amount of lime in its passage through Bihar (Fig. 1). The tributaries joining the Ganges from south flow through the limestone outcrops of Bihar. The difference in the proportion of lime content between the Ganges and Brahmaputra alluvium is so marked that on this basis the two alluviums can be easily differentiated. In Kushtia District where the distributaries of the Ganges no longer overflow their banks, lime concretions are found at a depth of one and one-half to two feet (Beers, 1955, p. 9).

The chemical composition of the alluvial soils also differs with their location in respect to the rivers. Calcium and phosphate content decreases and organic matter increases with distance from the levee crests. Nitrogen is barely sufficient (0.1 per cent) for plants to grow. Potash deficiency is not a serious problem and the alluvial soils in
most parts are acidic (Government of East Bengal, 1952, pp. 24-25). The pH of the Tista River (Fig. 1) silt ranges from 6 to 6.5 (Siddiqui and Mohammad, 1951, p. 295). Clay loams of Kushtia has a pH of 6.5 (Beers, 1955, p. 13), and loamy clays of Karimganj (Fig. 1) (Sylhet) 5.81 (Satyanarayan, Swaminathan and Viswanath, 1946, p. 317). The amount of available boron is slightly higher in the soils of Jessore, Khulna and Bakarganj Districts than those of Rangpur and Dacca Districts. But nowhere is the boron content sufficiently excessive to cause toxic effect, or sufficiently deficient to affect plant growth (Ghani and Haque, 1945, p. 261).

The soils of the southern part of the Ganges delta suffer from salt water encroachment. Heavy rainfall in the east and great amounts of fresh water at the river mouths on the eastern flank of the delta cause saline conditions to increase from east to west. The salinity problem is particularly acute in the lands reclaimed from the Sunsarbans forest in the Khulna District. Earth embankments about two to three feet high have been built along the river banks to control the invasion of saline water. Breaches in the embankments are common and once a breach takes place and saline water enters the field, it takes at least two years before the land can be recultivated. It is a mono-cultural area producing only "aman" rice of salt-resistant variety (Beers, 1955 A, p. 67).

Soil erosion is not significantly important in the flood plains of East Pakistan. Although some erosion takes place along cut banks of rivers, level topography retards erosion. Malpractices are causing a decline in soil fertility. Irregular plowing is common which promotes sheet and gully erosion. Fields are planted year in and year out with little fertilization. Fallowing and rotation are not in general practice
and productivity is decreasing.

Clays

Clays are found in the "bil" areas of East Pakistan. "Bil" areas receive the fine-grained alluvial sediments. The percentage of sand is very small and that of silt and clays, high. The soils are sticky when wet and hard and baked when dry. Drainage is poor and water logging is common. During rainy season, the "bils" become reservoirs of water and some of them retain water throughout the year.

Clays of East Pakistan are rich in organic matter due to the decomposition of aquatic weeds and other vegetation. The organic matter imparts a dark color to the soils. The nitrogen and potash content is high (more than 0.1 per cent) but the soil is deficient in phosphates (Government of East Bengal, 1952, pp. 24-25).

"Bils" lying just north of the Sundarbans are inundated by saline waters during the winter season. In summer, heavy rainfall and fresh water carried into them by "khals" lowers their salinity to a level that cultivation is possible (Beers, 1955 A, pp. 11-14).

Clays are mono-cultural. They produce either "aman" rice sown in April or "boro" rice sown in November and December. "Aman" rice keeps pace with the rising flood level and "boro" rice thrives in soils with abundance of moisture where the "rabi" crops will not grow.

Swamp Soils

Swamp soils cover 2,316 square miles of the coastal area of Khulna district in East Pakistan (Government of East Bengal, 1953, p. 26). It is a flat region where the rivers divide into numerous distributaries and tidal channels. The alluvial sediments are spread over the region by rivers and tides. The whole area is covered with mangrove forest which
are part of the government forest reserve. The swamp soils are tenacious clays which become more compact with distance from the rivers. There is abundance of organic matter and peaty conditions have developed in some places. The ingress of sea water has made the soils saline.

LOUISIANA

Like East Pakistan Louisiana has a variety of soils, mature and immature. Tertiary rocks and the Pleistocene terrace sediments have developed mature soils. Soil of the Tertiary hill areas is generally different from that of the Pleistocene Terraces, but a similarity is witnessed where the Pleistocene terraces attain marked relief. In the Pleistocene terraces, the soils derived from the loessial materials are different from those of other composition. Recent deposits laid down by the Mississippi River and its tributaries are immature soils. Red River alluvium is different from the Mississippi River alluvium in color and chemical composition. The Gulf coast area has developed a distinct soil with its marsh vegetation and poor drainage. Louisiana can, thus, be divided into the following soil divisions (Plate II B):

Hill Soils
Flatwood Soils
Prairie Soils
Bluff and Terrace Soils
Alluvial Soils
  Mississippi River Bottom
  River Bottom
  Coastal Marsh and Swamp Soils

Hill Soils

Hill soils of Louisiana cover the Tertiary hills area and northeastern part of the Florida Parishes. They are residual soils formed by
the decomposition of Tertiary sandstone, siltstone, limestone and ironstone. Also included are some of the older Pleistocene sediments. They exhibit the best development of profile among the Louisiana soils. Laterization and leaching are common to all the soils, but they differ in color, texture and chemical composition. Differences have been imparted primarily by the parent materials. Orangeburg, Ruston, Norfolk, Kirvin, Nacogdoches and Susquehanna are some of the important soil series (Emerson, 1916, pp. 24-25).

Norfolk, Ruston and Orangeburg soils have certain similarities. The Norfolk and Ruston soils were derived from unconsolidated sand and clay, and the Orangeburg from impure limestone. Orangeburg and Ruston develop in highly dissected areas, so are more oxidized than the Norfolk. The A horizon of all three types consists mainly of pale-yellow sands or loamy sands. Sometimes the Orangeburg series have heavier texture and are reddish in color. The "B" horizon is composed of clays but the color is yellowish in Norfolk and reddish in Ruston and Orangeburg. These are friable and well drained soils (Marbut, 1935, p. 42).

Nacogdoches and Kirvin soils have developed from unconsolidated Tertiary sandy clays and clays containing glauconite. They are found on rolling to hilly lands. The Kirvin is a light brown to reddish-brown, very fine sandy loams, whereas the Nacogdoches is reddish-brown to red, gravelly sandy loams. Subsoil in both cases is red in color and highly oxidized. Fragments of ironstone are also found in the subsoil (Marbut, 1935, pp. 53-54; Sturgis, 1955, p. 1).

Susquehanna soils have developed from clays, slightly calcareous or non-calcareous. They occupy rolling to gently rolling land and are
heavy textured, very fine sandy loams. Their color varies from light brown to grayish-brown. The subsoil is plastic clay generally yellowish in color, but becomes reddish with increasing depth. Drainage is poor (Marbut, 1935, p. 43; Sturgis, 1955, p. 3).

Hill soils have been greatly leached. Hydrous oxide of aluminum and iron have been left behind. These soils are highly acidic in reaction, with the pH around 5.0. Soil erosion is excessive and was accelerated after the fields were plowed (Pearson and Ensminger, 1957, pp. 579-581).

Pine forests originally covered the hill soils. Large areas were cleared and planted with cotton. Some corn was also raised. The soils soon began to show signs of exhaustion and erosion was accelerated. Today large areas are returning to forest or pasture.

Flatwood Soils

Flatwood soils are found in several areas of Louisiana. One is east of the Mississippi River covering largely the prairie terrace, another is west of the Mississippi River lying between the Prairie terrace in the south and Tertiary hills in the north. Three small areas are located in the Tertiary hills area. They are covered with pine, maple, green ash, oak and hickory. Some areas have been cleared for agriculture.

Flatwood soils are derived from Pleistocene terrace sediments and are mature soils. Caddo and Beauregard soil series are the most widespread. Caddo soils are very fine sandy loams or fine silt loams of gray color. The subsoil is generally pale yellow, very fine sandy or silty clay loam. In lower subsoils, red mottling are sometimes found. Beauregard soils are very fine sandy loams. Their color is grayish-brown. The subsoil is somewhat plastic, very fine sandy or silty clay loams of yellow-red or gray colors. The flatwood soils are generally easy to work, but drainage
is poor (Sturgis, 1955, p. 4).

Flatwood soils are deficient in plant nutrients. Nitrogen and phosphorus contents are low. Potassium has been leached to the lower horizon. Calcium and magnesium are also deficient (Walker, 1920, pp. 16 and 19). The flatwood soils need elaborate treatment before they are profitably cultivated. In spite of suitable topographic conditions, large areas are still uncultivated, and the cultivated areas must be heavily fertilized. The major part of the cultivated area is under pasture. Cotton, corn and strawberries are the notable crops.

**Prairie Soils**

Prairie soils cover the Prairie terrace of southwestern Louisiana. This area is generally flat with slopes of one and one-half to two feet per mile towards the Gulf of Mexico. The natural vegetation is tall, bunch and coarse grasses.

Coastal prairie soils are derived from the materials of the Prairie terrace. They are mature soils. Surface soils are friable, light-brown, silt loams. They are underlain by plastic silt clays or clays. The subsoils are mottled with yellow, red or gray colors (Walker and Miears, 1957, p. 532). The Crowley series occupy the major part of the area, particularly the eastern part. They are silty in texture, light in color, and have an impervious, clayey subsoil. The Lake Charles series which predominates in the western part are heavier in texture and dark gray to black in color. The textural difference between the surface soil and subsoil is small. They are sticky when wet and slightly granular when dry (Emerson, 1916, p. 23; Soil Survey Division, 1938, p. 115; Walker and Miears, 1957, p. 532). The cultivation of rice has increased the stickiness, compactness and imperviousness. This is the result of prolonged flooding
necessary for rice cultivation. The flooding causes an increase in hydrolysis, and in the dispersible colloidal content. It also induces illuviation of iron and manganese to lower horizons (Fieger and Sturgis, 1934, p. 268). The virgin soils are finely granular but by cropping and irrigation, have become defloculated (Ibid., p. 269).

Prairie soils are deficient in nitrogen and phosphorus. The nitrates are never present in amounts greater than 3 parts per million. After flooding, the quantity of available nitrate decreases, and is not detectable by harvest time. The available phosphorus exhibits a similar rapid decline (Reed and Sturgis, 1939, p. 20). A slight deficiency of potassium is also encountered. Virgin prairie soils are commonly acid with a pH of around 6.0; but they tend to become alkaline after a few years of rice cultivation. This is caused by the introduction of sodium ions to the soils by irrigation water. Fortunately the amount of sodium present in the water is small and most of it is washed away by heavy rainfall. During periods of drought, water containing higher amounts of soluble salts are sometimes used (Rice and Griswold, 1903). In such periods the saline water from the Gulf of Mexico percolates through the soils. Thus a weak solonetz stage may be developed (Fieger and Sturgis, 1934, p. 268).

Prairie soils are noted for rice cultivation. The clay pan retains irrigation water standing in the field. To keep from depleting all the organic matter from the soils continuous rice cultivation is not practiced. Rice and pasture are rotated in alternate years. If rotation is not practiced, rice yields diminish even though fertilizers are applied (Reed and Sturgis, 1937, p. 7).

Poor drainage is the main problem of prairie soils. Land-leveling
practices and drainage ditches have considerably improved surface drainage but little can be done to improve the poor internal drainage. It undoubtedly helps the flooding of rice fields, but it prohibits the production of a number of crops and makes the soils difficult to work (Walker and Miears, 1957, p. 532).

**Bluff and Terrace Soils**

The terrace and bluff soils are among the productive soils of Louisiana. Their fertility level is generally lower than that of the Mississippi and Red River bottom soils since a slight deficiency exists in phosphate and potash content (Grissom, 1957, p. 529).

Bluff and terrace soils are found in five scattered localities in northwestern part of the Florida Parishes. West of the Mississippi River, the Bastrop Hills, the Macon Ridge and a triangular zone on the eastern edge of the Prairie terrace are the large areas of bluff and terrace soils. A small area is found in the Avoyelles Parish Prairie. These soils have been derived from Pleistocene and Recent sediments and have remained above the present flood plain for a considerable period of time so these soils are mature.

The bluff and terrace soils grade from very fine, sandy loams to silt loams. They have granular structure and can be easily worked. Drainage is fair to good. The color varies in accordance with the parent materials. The Memphis, Grenada, Olivier, Lintonio, and Calhoun are the important soil series (Sturgis, 1955, pp. 8-10).

Memphis and Grenada are the most extensive of the bluff and terrace soils east of the Mississippi River. They have been derived partly from loessial materials which are recognized by Russell as colluvial, backswamp deposits of the Montgomery, Bentley and Williana terraces (Russell, 1944, p. 12). The "A" horizon of the memphis is a three-inch layer of dark
colored silty material which is underlain by a heavier reddish-yellow "B" horizon. Grenada soils are similar to the Memphis except that the Grenada is found on flatter lands and the "B" horizon is mottled with gray spots. (Marbut, 1935, p. 44). Erosion has greatly depleted these soils. Cotton was once the chief crop. Today these soils have been returned to grasses or trees. Corn and sweet potatoes are grown to some extent.

Olivier, Lintonia and Calhoun soils are important on the bluff and terrace soils west of the Mississippi River. The parent materials are Pleistocene and Recent alluvial sediments. Surface soils are very fine sandy loams or silt loams. Small iron concretions are found in the Olivier series. The subsoil is silty clay loams (Sturgis, 1955 p. 9). Cotton is important in the north and sugar cane in the south. Corn, sweet potatoes and soybeans are grown and some land is also used as pasture.

Alluvial Soils

Mississippi River Bottom Soils

Mississippi River bottom soils cover the Mississippi Flood Plain and the Deltaic Plain. Derived from Recent deposits, these soils are immature. Their physical and chemical characteristics depend largely upon the source materials, depositional history and man's activities.

Physical properties of the Mississippi River bottom soils vary in accordance with the topography on which they are deposited. The Mississippi flood plain is marked with meander belt ridges which enclose irregular flood basins. The ridges are higher and the basins smaller in the northern part of the valley than the southern part. The soils on the levee ridges are sandy loams or loams (Sarpy and Yazoo Series). The subsoil is usually coarser and pure sands at a depth of a few feet are common (Marbut, 1935,
p. 45). On the levee slopes, silt loams and silty clays are found (Robinsonville and Waverly Series). The subsoil is usually a compact silty clay. Backswamps are generally heavy clays called "gumbo" or "buck shot" (Sharky and Galveston Series). The subsoil is usually the same as the surface. The color of the levee soils is generally gray. The backswamp soils become black because of abundant organic matter.

Coarse texture, crumby structure and better drainage make levee crest soils the easiest to work; conversely, backswamp soils are difficult to work because of their fine grained texture, cloddy structure and poor drainage. This is one reason why large areas of backswamps are still covered with forests. In many localities the soil structure on levee crests have been broken down by plowing when the ground was too wet. Hardpans and plowsoles have developed on back slope soils. Hardpans resist water and root penetration but can be eliminated by deep tillage (Grissom, 1957, p. 527).

With the exception of nitrogen, sufficient plant nutrients are contained in most of the Mississippi River bottom soils. Deficiency of phosphorus, potassium and lime occur only in a few small localities. The pH ranges from 5.3 to 6.8. Trace elements are available and fertility generally is high. Soils deposited by the Mississippi River are richer in plant nutrients than those deposited by small tributaries flowing from the Florida Parishes (Grissom, 1957, pp. 528-529). Backswamp soils have a high proportion of organic matter. Logs, stems, tree roots and layers of leaves are commonly found. The organic accumulation in backswamp soils have imparted acidity and peaty characteristics. They are usually too wet to be worked but compact and subside when dehydrated.
Most of the Mississippi River bottom soils suffer from nitrogen deficiency. The deficiency is overcome by planting legumes and the application of commercial nitrogen. Almost all crops need some amount of nitrogen, but corn and cotton require the most. Fertilizer is generally used as top-dressing (Grissom, 1957, pp. 529-530).

A variety of crops are grown in the alluvial soils of the Mississippi Valley. Cotton, corn and sugar cane are best adapted to the fine sandy loam, loam and silt loam soils. Rice does better on clays, silt clays, and silt loams that have a compacted layer. Soybeans grow equally well on sandy loams and clays. Pastures occupy a small proportion of alluvial soils. Generally silt clay and clay soils are used for pastures (Grissom, 1957, pp.530-531). A number of crops compete for the same soils. Usually climate and economic consideration determine the selection.

Mississippi River bottom soils are one of the most productive soils in Louisiana. Most levee crests and backslopes are cultivated, but large areas of backswamps are too wet to be cultivated. Levees along the Mississippi River have considerably controlled the overflow water and soil renewal by fresh alluvium has been eliminated. Fertility is being maintained by the use of artificial fertilizers and by planting legumes.

**Red River Bottom Soils**

Red River bottom soils cover the Red River Valley which extends from northwest corner of Louisiana to Marksville. The valley width varies from five to fifteen miles. The soils are largely immature Recent deposits. The sediments are derived from red beds of western Kansas, Oklahoma and northwest Texas. Red sedimentary parent material has imparted the red color to the soils (Emerson, 1916, p. 26). In some areas sediments older than Recent are also present but they have developed
imperfect profiles. Their color is generally brown or yellow in various shades. The Portland and Bastrop are the common series in the older soils. This group and the Miller and Yahola are the common series among the Recent deposits (Sturgis, 1955, p. 11).

Red River alluvial soils are rich in calcium carbonate, potassium and phosphorus, but are poor in nitrogen. Leaching has not altered the Recent deposits but the older deposits are slightly leached. In leached areas, the calcium carbonate has alluviated to the "B" horizon (Lovett and Davis, 1937, p. 7).

The Red River bottom soils can be distinguished from the Mississippi River bottom soils by red color and higher percentage of line. In productivity both of them rank high. The texture, structure and drainage are also similar. Cotton is the chief crop of the Red River Valley. Corn and soybeans come next. In some areas alfalfa and pasture are grown. The application of nitrogen is beneficial in case of all crops.

Costal Marsh and Swamp Soils

Coastal marsh and swamp soils occupy an area of about three and one-half million acres along the Gulf coast of Louisiana. Silts and clays of alluvial and marine origin and the accumulation of organic plant material are the primary sediments in marsh soils. On natural levees soils are gray or grayish brown in color and are fine textured with no structure. Peat and muck soils cover large areas of the coastal marsh seaward and between the natural levees.

In the western part, very little alluvium is being deposited by the streams at the present time, whereas in the eastern part, significant alluviation is in progress. The whole area is a low plain slightly above Gulf level and has resulted in poor drainage. Grasses and bushes comprise
the typical vegetation. Along the natural levees, beaches and on the salt domes, clumps of trees are found. Marsh soils are highly acidic. The pH of clays range from 2.5 to 6.0, that of muck soils from 3.3 to 5.8, and that of peat soils is slightly higher than muck (Lytle and Driskell, 1954, pp. 27-28). These soils are rich in organic matter, calcium, potassium, sodium, chlorides and sulphates. Peat soils have a higher percentage of these substances than mucks, and mucks are richer than clays. Amounts of sulphates and chlorides increase in brackish water. Carbonates are almost absent from the soils (Lytle and Driskell, 1956, pp. 25-31).

SUMMARY

East Pakistan and Louisiana both have mature soils on the Tertiary hills and the Pleistocene terraces, and immature soils on the Recent flood plains. Hill soils in both areas have been laterized, leached and eroded, and are deficient in plant nutrients. This is specially true of East Pakistan. Large areas of the hill soils are covered with forest. In Louisiana, considerable areas were cleared for cotton culture but are now fallow and are returning to forests and grassland.

Pleistocene soils are mapped in Louisiana but only the Red Soil type is recognized in East Pakistan. In East Pakistan there is no counterpart of the loessial and prairie soils of Louisiana. The highly oxidized and deeply eroded soils of northern Florida parishes have a resemblance with those of the Madhupur Jungle and the Lalmai Hills. The flatwood soils may be broadly compared with the soils of the Barind area (Table 3).

The alluvial soils are among the most fertile soils of East Pakistan and Louisiana. The soils on levee crests and back-slopes have
higher agricultural importance than those on the backswamps and "bils." The Ganges River alluvium is rich in lime as is the Red River alluvium. Nitrogen deficiency is present in alluvial soils of both areas. No other nutrient seems to be significantly deficient. The general fertility level of East Pakistan alluvial soils is declining. The decline is more pronounced in the deltaic plain west of the Garai-Madhumati River where the rivers do not overflow. In the rest of the area, a fresh layer of silt deposited by annual floods, rejuvenates the soils. In Louisiana where floods are not annual occurrences and where the construction of levees has greatly controlled the streams, heavy application of fertilizer maintains soil fertility. Clay soils which are least suitable for agriculture among the alluvial soils are less extensive in East Pakistan than in Louisiana.

### TABLE 3

Approximate Area of Equivalent Soil Division
East Pakistan and Louisiana

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<th>Soils</th>
<th>East Pakistan</th>
<th>Louisiana</th>
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<td>Sq. Miles</td>
<td>Sq. Miles</td>
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<td>Prairie</td>
<td></td>
<td>3,315</td>
</tr>
<tr>
<td>Bluff and Terrace</td>
<td></td>
<td>4,719</td>
</tr>
<tr>
<td>Alluvial</td>
<td>41,330</td>
<td>19,237</td>
</tr>
<tr>
<td>Coastal Marsh and Swamp</td>
<td>2,316</td>
<td>5,469</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>54,141</strong></td>
<td><strong>48,523</strong></td>
</tr>
</tbody>
</table>

Compiled from various sources
CLIMATE

East Pakistan and Louisiana have certain climatic characteristics in common. Summer in both areas is characterized by high temperature, high humidity and heavy rainfall. Conditions in winter are different, however. East Pakistan has cool and dry winters and does not experience frost. So East Pakistan enjoys a year-round growing season but Louisiana does not.

Annual precipitation in both East Pakistan and Louisiana is high but the seasonal distribution in the two areas is different. East Pakistan has well marked wet and dry season, while Louisiana has no dry season.

These similarities and differences are well reflected in the agriculture of the two areas. In East Pakistan, farming is carried on throughout the year. In Louisiana, winter is the period of relative inactivity. Few crops can be grown in winter without irrigation. In Louisiana irrigation is of supplemental character. The two areas grow a number of the same crops but also have different ones peculiar to their respective climatic conditions.

EAST PAKISTAN

East Pakistan lies between 21° and 27° north latitude. The Tropic of Cancer passes almost through the middle of the province. The major part of East Pakistan is a low-lying plain with an average elevation of twenty-five feet above sea level. Sections of Pleistocene terraces
occasionally rise 100 feet above sea level. To its south lies the Bay of Bengal; highlands with elevations of no less than 2,000 feet surround it from the remaining three sides.

Winds blow from the sea from March to October, so they are moisture laden. They are intercepted by the surrounding highlands and lifted up, condensation is thus produced and rainfall occurs. Winter winds blow seaward and are dry but never cold like those of Louisiana. Cold winds from central Asia are blocked by the Himalaya Mountains.

Temperature and rainfall are the two most important climatic elements influencing the agriculture of an area. Sunshine, light and humidity which also effect crop production are closely related with temperature and rainfall. Hail storms, hurricanes, typhoons and other storms are occasional occurrences of local importance. Hence, temperature and precipitation deserve special consideration in the study of agriculture in East Pakistan and Louisiana.

**Temperature**

East Pakistan has a short winter and a long summer. The winter season begins in November and continues until February. The change from summer to winter is rather abrupt. The temperature* at Chittagong drops 5.6° from October to November, at Dacca 6.9° and at Bogra 7.8°. January is the coolest month. The isotherms run parallel to the latitude and decreases in value from south to north (Plate III A). The average January temperature at Chittagong is 66.9°, at Dacca by 66.5°, at Bogra 63.9°, and Dinajpur 62.5°. No locality experiences frost. The lowest temperature ever recorded was 34° at Dinajpur on February 3, 1905

* All temperatures are in Fahrenheit unless otherwise stated.
PLATE III

EAST PAKISTAN
JANUARY ISOTHERMS

SOURCE OF DATA: Memoirs of India Meteorological Department,
Vol. XXVII, Part V

LOUISIANA
JANUARY ISOTHERMS
(After Dyke)
SOURCE OF DATA: Memoirs of India Meteorological Department, Vol XXVII, Part V

(After Dyke)
LOUISIANA
JANUARY ISOTHERMS
(After Dyke)
The temperature, therefore, does not limit agricultural activity in East Pakistan. Summer in East Pakistan begins in March and continues until October. The change from winter to summer is as abrupt as from summer to winter. The temperature at Chittagong rises by 6.6° from February to March, at Dacca by 8.1° and at Bogra 9.2°. In April the temperature rises to 80° and remains so until October. Temperatures from April to September remain so uniform that it is difficult to single out a month and label it as the hottest. But April is usually considered the hottest month with a secondary rise of temperature in September. Temperatures from May to August tend to rise higher due to the high altitude of the sun but heavy rainfall offsets the tendency. The temperature differences from month to month are very small (Table 4).

**TABLE 4**

Temperature at Selected Stations and Selected Months in East Pakistan

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>APRIL °F</th>
<th>JULY °F</th>
<th>SEPTEMBER °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chittagong</td>
<td>81.0</td>
<td>81.30</td>
<td>81.70</td>
</tr>
<tr>
<td>Naraganganj</td>
<td>83.6</td>
<td>83.5</td>
<td>83.7</td>
</tr>
<tr>
<td>Khulna</td>
<td>84.7</td>
<td>83.2</td>
<td>83.7</td>
</tr>
<tr>
<td>Rajshahi</td>
<td>85.0</td>
<td>84.0</td>
<td>83.0</td>
</tr>
<tr>
<td>Dinajpur</td>
<td>82.1</td>
<td>84.0</td>
<td>83.3</td>
</tr>
</tbody>
</table>

The summer isotherms in East Pakistan do not follow the latitudes (Plate III B). They run from north to south and curve eastward in the central part of the provinces. Their alignment is controlled by rainfall distribution and their value increases from east to west as the rainfall decreases. Their eastward bend in the central part of the province indicates that the places on the same longitude have different temperatures in accordance with their location. Those in the central part are hotter than those in the northern or southern parts, coinciding with less rainfall in the central sections. The west central part of East Pakistan becomes hottest in summer and records temperatures over 86° in April, while the eastern part has temperatures below 81°.

East Pakistan normally does not experience hot winds ("loo") which are characteristic of the Indo-Gangetic plain from Bihar westward. In years when sufficient rainfall does not take place in the nor'wester season, mild forms of "loo" blow in the northern part of the province west of the Jamuna (Brahmaputra) River.

The annual range of temperature in East Pakistan is least near the Meghna mouth (13°) where the sea has the greatest inland extension (Chatterjee, 1949, p. 22). The annual range increases in all directions from the area. The highest range of 18° is recorded in the northern part of the province. The diurnal range is higher in winter. In January, the coldest month, it ranges from 20° to 25° on the average. Due to clear skies, insolation is high in the daytime and radiation is rapid at night. The calm atmosphere also contributes to rapid radiation. As the rain starts and clouds cover the sky, the diurnal range decreases. It becomes
least in the month of highest rainfall, June, July and August. The diurnal range then varies between 7° and 10° with less in places of heavier rainfall and more in areas of lighter rainfall.

**Rainfall**

East Pakistan is a humid region receiving an average annual rainfall of eighty inches (Plate IV D). Three areas receive heavier rainfall, the southeastern part, the Sylhet Basin and the northern extremity of the province. Rainfall in these areas is more than 100 inches annually. The west central part is the driest which receives less than sixty inches. The remaining area constitutes the major part of East Pakistan which receives sixty to one hundred inches of annual rainfall.

Rainfall in East Pakistan is not well distributed throughout the year. Variation from season to season is so well marked that the year can be divided into three rainfall periods: Winter or Dry, Summer or Nor'wester, and Rainy or Monsoon.

Winter season in East Pakistan extends from November to February, during which land winds blow from the northeast. Hence winter is the driest season and is noted for sunny days and starry nights. Occasionally weak depressions from the west enter the northern part of the province and drizzles may occur. These depressions rarely cross the Brahmaputra River. In the remaining part of the province minor convective showers may occur. Winter rainfall hardly accounts for four per cent of the annual total. The area east of the Jamuna River receives the least winter rainfall, less than two inches (Plate IV A). The
EAST PAKISTAN
AVERAGE WINTER RAINFALL
(NOV.-FEB.)
IN INCHES

SOURCE OF DATA: Memoirs of India Meteorological Department, Vol. XXVII, Part V

EAST PAKISTAN
AVERAGE MONSOON RAINFALL
(JUNE-OCTOBER)
IN INCHES
EAST PAKISTAN
AVERAGE NOR'WESTER RAINFALL
(MARCH-MAY)
IN INCHES

SOURCE OF DATA: Memoirs of India Meteorological Department,
Vol. XXVIII, Part V

EAST PAKISTAN
AVERAGE ANNUAL RAINFALL
IN INCHES
EAST PAKISTAN
AVERAGE MONSOON RAINFALL
(JUNE-OCTOBER)
IN INCHES

SOURCE OF DATA: Memoirs of India Meteorological Department,
Vol. XXVII, Part V
EAST PAKISTAN

AVERAGE ANNUAL RAINFALL
IN INCHES

SOURCE OF DATA: Memoirs of India Meteorological Department, Vol. XXVII, Part V
highest rainfall of the season, about four inches, is recorded by the Chittagong coast and the eastern corner of the Sylhet District.

Considering the temperatures alone, the period from March to October in East Pakistan may be termed summer. During the latter five months, however, the rainfall is so heavy that they are designated the rainy season, and the time from March to May is called the summer season.

Summer season in East Pakistan coincides with the period of "nor'wester" thunderstorms. They are locally termed "Kal Baisakhi" (calamities of the month of Baisak, i.e., April-May). The name nor'westers is applied to these thunderstorms because they usually come from the northwest. They may, however, come from any point of the compass. Though some occur in February, they generally begin in the month of March. They continue with increased frequency until the monsoon breaks in June. The monsoon currents seem to dissolve and disperse the nor'wester thunderstorms (Houghton, 1925, p. 408).

Conditions which favor the development of the nor'wester in East Pakistan are warm, moist southerly winds up to a height of two kilometers. Above that there is a relatively cool and dry air drift from northwest and west. Hence only a trigger action is required to release the energy and cause thunderstorms and it is provided by the lifting of the moist currents when they reach the Chotanagpur Plateau, the Himalaya Mountains or the Assam Plateau. The lifting is also caused by the Katabatic winds which flow down the Brahmaputra and Surma valleys. Thunderstorms die out after the moist air is exhausted (India Meteorological Department,
The nor'westers differ from the tornadoes in having little whirling motion of the air. But sometimes they develop into tornadoes (Sen, 1931, pp. 128-129).

Nor'westers occur most commonly in the afternoon or early evening in the western part of East Pakistan and between seven and ten p.m. in the eastern part. The nor'westers move at a speed of twenty-five to fifty miles per hour, associated squall velocity is forty to sixty miles, which may even rise to over seventy-five miles (India Meteorological Department, 1944, A, pp. 2-3). Nor'westers come with complete suddenness, last for a few hours at a maximum and disappear as suddenly as they come. They leave fallen trees, destroyed roofs, and upturned boats in their wake. They extend over an area of a few miles to 350 miles wide and usually dissipate before they travel 150 miles. They are more frequent and also more severe in southeastern East Pakistan. Nor'westers are invariably accompanied by rainfall, thunder and lightning. Hailstorms with hailstones over three inches in diameter, large enough to damage aircraft and kill animals, sometimes occur (India Meteorological Department, 1944, p. 8; Houghton, 1925, p. 407).

Nor'wester rainfall occurs in showers. During an average storm less than one inch of rain falls but at times heavier showers occur. Rainfall measuring 20.67"fell at Noakhali (Fig. 1) in 1897 during a nor'wester storm (Manager of Publications, 1953, and Walker, 1933). Nor'westers are most common in the eastern part of the province (Plate IV B). The fifteen-inch isohyet for March through May approximately divides the province in half. The western part receives less
than fifteen inches; Rajshahi District receives the least rain, less than ten inches. Rainfall increases eastward with the major part of the Sylhet Basin receiving more than thirty inches during the season. May is the main month when one out of three days is wet (more than one inch of rainfall). East Pakistan on the average receives one-fifth of its annual rainfall during this season. Yearly variability is considerable, as is commonly with thunderstorms.

The rainy season in East Pakistan begins in early June when the southwest monsoon arrives. The monsoonal winds reach the peak of their activity in July and August, become weaker in September and disappear completely in October. The southwest monsoon is not a sea breeze on a large scale. It is the northward extension of the southeast trade winds which are deflected to the right after crossing the equator and become southwest winds (Simpson, 1921, pp. 161-162).

East Pakistan receives the full blasts of the Bay of Bengal branch of the southwest monsoon. Cyclones forming at the head of the Bay cross this province before reaching India and West Pakistan. The result is that East Pakistan is one of the rainest regions of the Indo-Pakistan subcontinent. The Assam Plateau, the Tripura Hills, and the Chittagong Hills on the east, and the Himalaya Mountains on the north are mainly responsible for the orographic rainfall which occurs in the Sylhet, Chittagong, Chittagong Hill Tracts and Noakhali Districts and the northern parts of Mymensingh, Rangpur and Dinajpur Districts. In the rest of the province the rainfall is mainly cyclonic. Rainfall decreases rapidly westward. West central East Pakistan is the driest
region, recording a rainfall of less than 50 inches during the season (Plate IV C).

Monsoonal rainfall in East Pakistan does not usually come in sudden showers like those of the nor'westers. Once begun rainfall may continue for several days with short breaks. The sky is often overcast for eight to ten days at a time. But the rainfall is by no means uniformly distributed over the whole rainy season; spells of dry weather occur between wet periods. Monsoonal rain diminishes in September and October but during these two months brief showers occur (Manager of Publications, 1955).

East Pakistan receives more than seventy-five per cent of its annual rainfall in the monsoon season. Rain variability in this province is least in comparison to other provinces of India and Pakistan. The monsoonal rainfall varies by about fifteen to twenty per cent from normal in the eastern part and by twenty to twenty-eight per cent in the west-central part (Clark, 1932, p. 289).

**Climate and Crops**

East Pakistan enjoys a year-round growing season. Average January temperatures vary from 66° in the south to 62° in the north. Average minimum temperatures at the coolest station are about 50°. Thus winter temperature is adequate for the production of tropical crops such as rice, and cool enough for the cultivation of temperate crops like wheat. Citrus fruits are marketed in winter, while other tropical fruits are produced in summer.

With temperatures a high constant, rainfall is the chief climatic
variable influencing East Pakistan agriculture. Generally speaking, East Pakistan is humid, but the monthly distribution of rainfall presents a picture of marked seasonal differences. Four months are more or less dry. Rainfall starts in March but even in April, it is not sufficient to replenish depleted soil moisture. Because of dry winters a water deficit prevails in East Pakistan from November to April. The average water surplus in most areas occurs in June, July, August and September (Plate V A).

The annual variability of rainfall in East Pakistan is fifteen to twenty per cent from normal in the west central part. In other sections it is less than fifteen per cent and becomes less than ten per cent in the coastal area (Williamson and Clark, 1931, pp. 45 and 48). In an area with a marked variation in seasonal distribution of rainfall, the annual variability does not reveal the degree of reliability of rainfall. In the months of soil moisture deficiency, variability is not of great significance, since irrigation facilities are ordinarily available. It is the variability during the period of water surplus which is more critical. Thus the variability of monsoonal rainfall in East Pakistan is of primary importance.

The variability of the monsoonal rainfall in East Pakistan is fifteen to twenty per cent from normal, which may be said to be small in view of the heavy rainfall during that season. The driest station, Lalpur (Fig. 1), receives 37.05 inches of rain during the monsoon period. The highest variability of monsoonal rainfall is twenty per cent. If Lalpur receives twenty per cent less than average in a particular year,
EAST PAKISTAN
WATER BALANCE

SOURCE OF DATA: LABORATORY OF CLIMATOLOGY, ELMER, NEW JERSEY

- PRECIPITATION
- POTENTIAL EVAPOTRANSPIRATION
- ACTUAL EVAPOTRANSPIRATION
- WATER SURPLUS
- SOIL WATER RECHARGE
- SOIL MOISTURE UTILIZATION
- WATER DEFICIT
LOUISIANA WATER BALANCE

SOURCE OF DATA: LABORATORY OF CLIMATOLOGY, ELMER, NEW JERSEY
it will still get about 28.90 inches. This is adequate for many crops. East Pakistan appears well supplied with moisture during the rainy season, even if maximum variability is considered. However, when the moisture holding capacity of the soil is considered, the question of rainfall sufficiency is reopened.

Soils have limited moisture holding capacity. At no time can the amount of moisture exceed that limit, no matter how heavy the rainfall may be. Thus the total rainfall in a given rainy season may exceed the amount of potential evapotranspiration, but in case the rainfall in any one of the rainy months falls below potential evapotranspiration a water deficit will occur. So monthly variability must also be considered.

In East Pakistan, the variability of rainfall from normal in July and August which are the months with least variability, is thirty to forty per cent (Clark, 1932, p. 289). In October it exceeds seventy-five per cent in the west-central section and ranges between forty-five and eighty per cent in the eastern part. In other words, variability is considerable. A water deficit may be experienced even in the normally rainiest month. So, seemingly humid and superhumid conditions are not always adequate for crops.

Another aspect of the monsoonal rainfall in East Pakistan reduces its reliability. Rainfall takes place neither every day nor in regular intervals but occurs in spells. It may rain for several days and then dry conditions may prevail for a number of days. Sometimes the dry spells are long enough for the crops to suffer from drought. The monsoon in East Pakistan may come late or go early. In the first case the nor'wester rainfall saves the crops, but in the latter case much damage
is caused to the ripening "aman" rice. In short, seasonal character of rainfall, high monthly variability, long dry spells within the rainy season, and late arrival and early departure of the monsoon make irrigation during winter and supplemental irrigation during other months a necessity in East Pakistan.

Seasonal and areal distribution of rainfall in East Pakistan determines to a considerable extent the crops grown, their sowing and harvesting times, and their yield. Crops with a heavy water requirement, like jute and rice of "aman" and "aus" varieties, are grown in the rainy season, while wheat, pulses and oil seeds are winter or "rabi" crops. The nor’wester rainfall makes it possible to sow jute and "aus" in late March and early April. The areas getting heavier rainfall during the season grow more of these two crops and also get larger yields. Ten inches or more of May rainfall ensures higher yield and better quality of jute. The nor’wester rainfall, however, interferes with the harvesting of winter crops and hence they are grown mostly in areas with lesser amounts of nor’wester rainfall. "Aman" rice which is mostly sown broadcast is planted with the first monsoon shower. It grows with the accelerating intensity of the monsoons. Plenty of sunshine and occasional heavy showers in September and October help it to ripen. Sometimes these showers fail and the yield is reduced. Sometimes the showers become more frequent and fungus diseases develop. September and October rainfall is also useful for sowing "rabi" crops. The dry November and December months are necessary for harvesting "aman" rice. January and February drizzles though few in number, help the "rabi"
crops in the northern part of the province.

LOUISIANA

Louisiana lies wholly north of the Tropic of Cancer between 29° and 30° north latitude. It is primarily a low-lying plain with elevation increasing gradually from the coast inland. Pleistocene terraces generally stand some fifty to one hundred feet above sea level, though in places they attain 300 feet. The highest point is 535 feet. Elevation everywhere is comparatively low and its effect on climate is slight. Louisiana opens to the Gulf of Mexico in the south and merges into the Gulf Coastal Plain on the three sides.

Unlike East Pakistan, orographic rainfall in Louisiana is virtually nil, and polar air-mass has easy access from the north. Polar air-mass is largely responsible for cold winters and some cool summer days. Louisiana's location also permits the entry of tropical air-masses causing hot and moist conditions. Convergences of the polar and tropical air-masses at times cause the formation of storms. Since the seasonal reversal of wind is not so pronounced as in East Pakistan, rainfall is well distributed throughout the year.

Temperature

Louisiana presents greater contrasts in summer and winter temperatures and greater differences in winter temperature from the coast inland than does East Pakistan. In winter, Louisiana alternates between cold continental air and warm tropical air. The ameliorating influence of the sea is intensified in that season. The difference between the temperature of Louisiana and that of the Gulf water along
the northern shore is 12° during the coldest month. In the warmest month the difference is 2° (Dyke, 1941, 902). The presence of a greater number of lakes in this coastal area adds to the modifying influence of water bodies. However, the moderating influence of the Gulf is quickly lost inland and there is a great temperature contrast between north and south Louisiana in winter.

The January isotherms in Louisiana run more or less parallel to the lines of latitude (Plate III C). The temperature decreases from the coast inland showing especially the influence of the sea but also reflecting the sun's altitude and variations with latitude. Burrwood (Fig. 2), the southernmost station located on the coast, records the highest average January temperature (57.1°), whereas Plain Dealing, close to the Arkansas line, records the lowest (46.0°). The average January temperature at Baton Rouge is 52.4°, at Alexandria 51.2° and at Shreveport 47.8° (U. S. Weather Bureau, 1953). The average temperature does not reflect the actual intensity of the cold. Examining the mean minimum January temperature one finds that Plain Dealing (35.3°) remains only a few degrees above the freezing point, whereas Burrwood (49.0°) records a higher temperature than the average January temperature of many stations in north Louisiana. Taking the absolute minimum temperature into consideration, a similar difference between north and south Louisiana emerges. No station south of 31° north latitude has ever recorded a temperature below 0°, whereas, in north Louisiana, particularly in the northernmost parishes, many stations have experienced sub-zero temperatures. The absolute minimum temperature on record at Bastrop
is -12°, at Calhoun -13°, at Farmerville -15°, at Ruston -15° and at Minden -16° (Dyke, 1941, pp. 894-895).

No station in Louisiana has completely escaped frost, but the length of the frost-free period decreases and the frequency of frost increases with distance from the sea. Thus the contrast between north and south Louisiana is again marked. The first freeze in the fall occurs at the Arkansas line on November 1, while at the mouth of the Mississippi River freezing temperatures do not occur until December 26, a difference of about two months. The last freeze in springs occurs at the Arkansas line on March 26 and at the Mississippi River mouth on January 10, about two and a half months earlier. The result is that most parts of Louisiana south of 31° north latitude enjoy a growing season of 250 days. In north Louisiana the growing season is shorter and in parts becomes only 220 days long (Plate VII B). Burrwood has the longest growing season (353 days) and Liberty Hill (Fig. 2) the shortest (199 days). The length of growing season diminishes rapidly with distance from the Gulf of Mexico, thus at New Orleans it is 292 days at Baton Rouge 269 days and at Clinton 246 days.

The temperature in Louisiana begins to rise from February and reaches its maximum in July. The oceanic influence though not marked, is still felt. The rise in temperature in northern stations is more rapid than in southern stations. The average July temperature is about 82° both in coastal and inland areas, despite the more equatorward location of the coastal area (Plate III D). The mean maximum temperature at Burrwood is 89.0°, at Baton Rouge 90.0°, at Alexandria 93.5° and
at Shreveport 93.4°. Along a narrow coastal strip the temperature on hottest days rarely rises above 100° while it attains a maximum of 108° in the central part of the state and 114° in the extreme northeast. The marine influence is also observed in the diurnal range. At Burrwood the diurnal range in July is 12.9°, at Vermilion and Morgan City 19.2°. Further inland, at Clinton, it is 20.7°, at Ville Platte 20.0°. In the northernmost parishes, it is 25.5° at Plain Dealing and 21.2° at Bastrop.

**Rainfall**

Louisiana is a humid region receiving more than fifty-eight inches of rainfall annually. Between 1900 and 1939, the state as a whole has never been arid or semiarid on the basis of annual rainfall. Semiarid conditions have prevailed for not more than ten years at any station in the western half during that period (Thornthwaite, 1941). Subhumid conditions in the crop season have occurred in all areas except the southeastern part of the state.

The main rainfall factor of Louisiana is the southerly rain-bearing winds which come from the Gulf of Mexico and blow northeastward on entering the state. Consequently the rainfall decreases from south to north, and from east to west. The rainiest part of the state is located in the southeast and the driest in the northwest (Plate VII A). In winter the storms entering the state from the north are more active, hence in winter the northern part of the state is rainier than the southern part (Plate VI A). But no section is normally dry during any season.

Seasonal precipitation in Louisiana is much more evenly
LOUISIANA
AVERAGE SPRING PRECIPITATION
(MARCH–MAY)
IN INCHES

SOURCE OF DATA: U.S. WEATHER BUREAU

LOUISIANA
AVERAGE FALL PRECIPITATION
(Sept.–Nov.)
IN INCHES
LOUISIANA
AVERAGE SUMMER PRECIPITATION
(JUNE–AUG.)
IN INCHES

SOURCE OF DATA: U.S. WEATHER BUREAU
LOUISIANA
AVERAGE ANNUAL PRECIPITATION
IN INCHES
(AFTER DYKE)

PLATE VII
LOUISIANA

AVERAGE NUMBER OF DAYS WITHOUT KILLING FROST
(AFTER DYKE)
distributed than in East Pakistan. About sixteen inches of precipitation comes in winter, spring, and summer, and twelve inches in the fall. The influence of the Gulf of Mexico and the subtropical location of the state are reflected in the seasonal distribution of precipitation. North Louisiana gets more rainfall in winter and south Louisiana gets more in summer (Plate VI, A & C). The difference in the amount of rainfall received by the two regions is higher in summer (10 inches) than in winter (3 inches). Strong polar front rarely reaches the state in spring. Tropical cyclones are rare thus rainfall is evenly distributed throughout the state (Plate VI B). In fall, the tropical cyclones are still active and cause heavier rainfall in the south than in the north (Plate VI D).

Snowfall in Louisiana is not very frequent and is usually small in quantity. The difference in amount and frequency of snowfall between north and south is noticeable. In south Louisiana snowfall is rare, while in north Louisiana it occurs nearly every year. On the average the annual snowfall in the south is less than an inch while it varies between one and ten inches in the north (Marvin, 1928, pp. 42-43). Sleet and glaze are rarer than snow and hail is not a common phenomenon.

Annual variability of rainfall in Louisiana is low. It is 12.8 per cent for the state as a whole, 12.4 per cent for south Louisiana and 13.3 per cent for north Louisiana on the basis of the twenty-five year record from 1923 to 1947. The variability increases when the seasonal precipitation is taken into consideration. In northern areas least variability is recorded in winter and highest in summer, while in the
south, highest variability takes place in the autumn and the season of least variability is different for different stations (Table 5). October is generally the month of highest variability and February the least.

**TABLE 5**

Variability of Annual and Seasonal Precipitation from Normal and the Months of Highest and Least Variability at Selected stations (Data 1926-1950)

<table>
<thead>
<tr>
<th>STATIONS</th>
<th>WIN-</th>
<th>SPR-</th>
<th>SUM-</th>
<th>AUT-</th>
<th>ANNUAL</th>
<th>MONTH OF HIGHEST VARIABILITY</th>
<th>MONTH OF LEAST VARIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WINTER</td>
<td>SPRING</td>
<td>SUMMER</td>
<td>AUTUMN</td>
<td>ANNUAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shreveport</td>
<td>29.0</td>
<td>29.2</td>
<td>47.1</td>
<td>30.6</td>
<td>14.9</td>
<td>July</td>
<td>February</td>
</tr>
<tr>
<td>Monroe</td>
<td>20.7</td>
<td>25.1</td>
<td>41.7</td>
<td>34.7</td>
<td>14.8</td>
<td>October</td>
<td>March</td>
</tr>
<tr>
<td>Alexandria</td>
<td>20.2</td>
<td>22.3</td>
<td>41.6</td>
<td>31.6</td>
<td>12.8</td>
<td>October</td>
<td>February</td>
</tr>
<tr>
<td>Amite</td>
<td>17.9</td>
<td>19.3</td>
<td>21.1</td>
<td>40.4</td>
<td>11.8</td>
<td>November</td>
<td>February</td>
</tr>
<tr>
<td>New Orleans</td>
<td>23.3</td>
<td>30.4</td>
<td>23.2</td>
<td>38.5</td>
<td>16.6</td>
<td>October</td>
<td>August</td>
</tr>
<tr>
<td>Morgan City</td>
<td>27.2</td>
<td>25.2</td>
<td>26.1</td>
<td>32.8</td>
<td>14.1</td>
<td>November</td>
<td>July</td>
</tr>
<tr>
<td>Lake Charles</td>
<td>22.8</td>
<td>32.0</td>
<td>32.9</td>
<td>29.6</td>
<td>14.6</td>
<td>October</td>
<td>February</td>
</tr>
</tbody>
</table>


**Climate and Crops**

Climate largely determines the identity of crops and their general distribution in Louisiana. Length of growing season and the amount of rainfall and its seasonal distribution are the chief climatic controls. The growing season varies from 353 days in the extreme southeast to
about 199 days in the north. In the coastal area, particularly in Plaquemine Parish, frost does not occur every year and severe frost (below 28°) is still more uncommon. So subtropical perennial crops like citrus fruits can thrive only in that area. Citrus trees in Plaquemine Parish were severely affected by frosts of 1899, 1940 and 1951 (Bederman, 1957, p. 5). The cultivation of sugar cane which needs a minimum of 250 frost-free days can extend up to the Mississippi line, while cotton which needs a minimum of 200 frost-free days can grow throughout the state.

While Louisiana generally gets a substantial amount of precipitation fairly well distributed, throughout the year, north Louisiana gets less precipitation than south Louisiana, though more precipitation in winter than in summer. The consequence is that June, July, August and September are the months of moisture deficit (Plate V B). A recent study of forty-one years of rainfall (1914-1954) and water requirements for cotton in the St. Joseph area (Tensas Parish) shows that every year the rainfall was inadequate for optimum cotton production (Holcombe and Wiegmann, 1955). Irrigation is thus desirable in north Louisiana.

In south Louisiana the period of maximum rainfall coincides with that of maximum temperature so the moisture deficiency is not acute in any month. But this is true only in normal years. The variability from year to year is considerable (Hoyt, 1936, p. 4). In some years, month-long droughts may occur. Thus at New Orleans, June rainfall in 1933 and 1936 was .59 and .71 inches, respectively, whereas, the
normal rainfall for the month is 5.57 inches (U. S. Weather Bureau, 1933 and 1936). Moreover, the rainfall is not evenly distributed within the season. Long dry spells are not uncommon. Rainfall often occurs in thundershowers and a considerable amount of water is lost as run-off. Consequently irrigation is also needed in south Louisiana.

The even distribution of rainfall in Louisiana throughout the year presents some problems. The absence of a dry period for ripening and harvesting has contributed much to the elimination of small grains from the state. More than ten inches of rainfall in the fall, the harvesting period, accounts for the small acreage under cotton in the southern part of the state. Only two inches of May rainfall is a hazard to the early corn plant which is at the critical tasseling stage in that month, while a rainfall below 2.5 inches in June and July is equally injurious.

In spite of a few frosty days in winter and high monthly variability of rainfall, Louisiana is well endowed with temperature and rainfall to grow a variety of crops. Rice, adapted to heat and moisture, is an important crop in Louisiana. Sugar cane, another crop from humid tropical regions, has long occupied a prominent place in the state's agriculture. Cotton, corn, tobacco, and citrus fruits, all requiring abundant heat and moisture, are grown with success.

The crops in Louisiana occasionally suffer from hurricanes and tornadoes. The hurricane season begins in June and ends in October, but hurricanes mostly occur in August and September. Louisiana had eighteen storms of hurricane intensity between 1879 to 1943 (Tannehill, 1943, p. 119). These storms are sometimes powerful enough to inundate
the narrow fringe of the coastal marshes with several feet of sea water. This is one of the contributing factors to the absence of agriculture in that area. Tornadoes, though more devastating in proportion to their size than hurricanes, affect small areas. Hence their climatic influence is small and their agricultural importance still less.

**SUMMARY**

The Tropic of Cancer passes through East Pakistan but lies to the south of Louisiana (Table 6). Thus East Pakistan may be expected to be slightly warmer than Louisiana. This is true in winter but in summer. The average January temperature in East Pakistan is about 64°, whereas it is 52° in Louisiana. Frost occurs every year in most of Louisiana, while it is unknown in East Pakistan. In summer the temperatures in both areas are almost equal (82°).

The occurrence of frost in winter has imposed on much of Louisiana a period of agricultural inactivity, the length of which increases sharply from south to north. In East Pakistan, agriculture is a year-round activity. Wheat, grams, lentils, mustard, tobacco and other crops are grown in winter. In summer rice and jute become important. East Pakistan grows tropical fruits like bananas, pineapples, mangoes and citrus fruits. In Louisiana, tropical fruits are unknown except citrus fruits which are also occasionally subjected to climatic hazards. The hot, rainy season, however, permits the growth of certain tropical crops, for example, rice, sugar cane and cotton.

Both East Pakistan and Louisiana receive large amounts of annual rainfall. The total precipitation in East Pakistan is more than
### TABLE 6
Latitudinal Extent, Some Climatic Characteristics and Major Crops of East Pakistan and Louisiana

<table>
<thead>
<tr>
<th></th>
<th>EAST PAKISTAN</th>
<th>LOUISIANA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitudinal Extent</td>
<td>21° N to 27° N</td>
<td>29° N to 33° N</td>
</tr>
<tr>
<td>Average July Temperature</td>
<td>82° F</td>
<td>82° F</td>
</tr>
<tr>
<td>Average January Temperature</td>
<td>64° F</td>
<td>52° F</td>
</tr>
<tr>
<td>Frost-free days</td>
<td>365 days</td>
<td>350 days in extreme south</td>
</tr>
<tr>
<td></td>
<td></td>
<td>220 days in extreme north</td>
</tr>
<tr>
<td>Frost</td>
<td>No frost</td>
<td>No place without frost</td>
</tr>
<tr>
<td>Annual Rainfall</td>
<td>80 inches</td>
<td>58 inches</td>
</tr>
<tr>
<td>Rainfall Regime</td>
<td>Dry winter and rainy summer</td>
<td>No dry season</td>
</tr>
<tr>
<td>Period of Water Deficit</td>
<td>November to April</td>
<td>July, August, September, in north Louisiana. Not acute in any month in south Louisiana</td>
</tr>
<tr>
<td>Annual Variability of Rainfall</td>
<td>About 15 per cent</td>
<td>About 13 per cent</td>
</tr>
<tr>
<td>Major Crops</td>
<td>Rice, pulses, sugar cane, tea, tobacco, and jute</td>
<td>Rice, corn, sugar cane and cotton</td>
</tr>
<tr>
<td>Fruit Crops</td>
<td>Bananas, pineapple, coconuts and citrus fruits</td>
<td>Citrus fruits, strawberries, peaches and pears</td>
</tr>
</tbody>
</table>
Louisiana, but East Pakistan experiences a marked dry season, unlike Louisiana. The dry period which occurs in winter is helpful for harvesting "aman" rice and sugar cane, but this advantage is offset by its long duration. Winter temperature conditions are favorable for plant growth in every part of the province, but agriculture is carried on only in areas where irrigation facilities are available.

Louisiana precipitation is distributed throughout the year. At times, rain interferes with the ripening and harvesting of certain crops. There are, however, dry spells of a few days' duration and harvesting can be accomplished. Rainfall in Louisiana is not adequate for the optimum growth of plants. In north Louisiana, the plants feel moisture deficiency every summer, whereas, in south Louisiana, long spells of dry weather affect moisture deficiency. Thus supplemental irrigation is desirable throughout the state. Water resources are adequate for the purpose and irrigation is gaining popularity. In East Pakistan without irrigation only limited agriculture is possible in winter, but in Louisiana, the absence of irrigation affects only the yield. Rice, a plant with heavy water requirements, is grown in East Pakistan without irrigation in summer, but in Louisiana it is an irrigated crop. This brings out the difference in the amount of rainfall received by East Pakistan and Louisiana in summer. It would have been advantageous for both East Pakistan and Louisiana if they could interchange their rainfall regimes.
CULTURAL SUCCESSION

Man has existed in East Pakistan since the Paleolithic age. Although agriculture was probably introduced during Neolithic times, the record is incomplete because recorded history did not begin until 326 B.C. In Louisiana the oldest Indian site (Poverty Point) was occupied 800 to 600 B.C. and agriculture is believed to have been in practice at that time. Before Europeans came to Louisiana, agricultural practices were similar to those in East Pakistan during Neolithic times. Since historic times rapid changes have occurred in Louisiana, but agricultural methods are still medieval in East Pakistan.

EAST PAKISTAN

Materials available for the reconstruction of agricultural practices of East Pakistan in ancient times are lacking. During the Gupta and post-Gupta periods (5th and 6th century A.D.) officers called "Postapalas" or record keepers maintained records of land with their boundaries, demarcations and titles. The Sena kings (12th century A.D.) had field-to-field cadastral maps and accompanying records of holdings and rentals. Unfortunately, not a fragment of these records is available. Archaeology and the accounts of foreign travelers and historians are the only available sources (Majumdar, 1943, p. 642).

Prehistoric Period

During Vedic times, East Pakistan was inhabited by non-Aryan people. Hornell suspects a strong Polynesian influence; Risley classified them as Mongolo-Dravidians (Risley, 1893, pp. 1-5). Chanda defied
Risley's view and proposed their derivation from the *Homo Alpinus* type, a brachycephatic people who lived in the Pamirs and the Takla Makan Desert and spoke an Indo-European language. According to Guha, Director of the Anthropological Survey of India, East Pakistan was first inhabited by Negritos (Chatterji, 1951, pp. 143-151). They were food gatherers who had no knowledge of agriculture. No trace of them is found today in the province and they were either driven out or completely absorbed by the Archaic Caucasoids who came from the west. The Archaic Caucasoid movements invaded Burma, Indonesia, Melanesia, and Polynesia. Back-washes of these people from Melanesia and Polynesia introduced new culture traits in East Pakistan.

Archaic Caucasoids were Neolithic in culture and spoke the Austric language. They probably laid the foundation for village life based on agriculture in East Pakistan. They brought with them a primitive system of farming in which the digging stick was used to till the land (Ibid., pp. 147-151). They introduced (as their Austric names suggest) the coconut (narikela), banana (khadala), betel-vine (tambula, betel-nut (guvaka), tumeric (haridra), ginger (sringavera) and several types of vegetables. Rice cultivation and the manufacture of sugar from sugar cane were likely introduced by them. They were not cattle breeders and did not use milk but were the first people to tame elephants and domesticate fowl. The custom of counting by twenties (kudi) appears to be a relic of Austric time (Idem.).

The next group of people to enter East Pakistan were Dravidians. These long-headed people were a mixture of Mediterraneans from the west
and people living in India and the Upper Ganges Valleys. Their speech has a close affinity with the Ural-Altaic family. They had attained a high level of civilization and introduced the city concept, international trade, and a well developed religion. Dravidians probably introduced the plow into the agricultural complex of East Pakistan (Ibid., pp. 154-160). A cultural and racial fusion of Dravidians and Austro-Asiatic-speaking peoples followed and this mixed group forms the bulk of the present population of East Pakistan.

The culture of East Pakistan was next enriched by the Caucasoid Aryans who entered West Pakistan before 1500 B.C. and made the Upper Indus Valley their home. After contact with the Dravidians, these semi-nomadic people became sedentary agriculturists and developed a complicated religious and social life. The caste system, which now dominated every facet of Hindu life, was their creation. From the Upper Indus Valley their culture spread into the Ganges Valley but did not reach East Pakistan until the 4th century A.D., when they were forced out of the Ganges Valley by the Gupta kings (Majumdar, 1943, p. 564).

Culturally primitive Mongoloids entered East Pakistan in the 7th century A.D. but did not add much to the advanced culture of East Pakistan. Although many were assimilated by the mixed Dravidians, a few preserved their culture by remaining in the hilly areas where they still practice shifting agriculture (Chatterji, 1951, p. 167).

**Early History (326 B.C. to 320 A.D.)**

At the time of Alexander's invasion of the Indus Valley in 326 B.C. East Pakistan was inhabited by the Gangaridai (Dravidian people from the
It is reported that they were waiting for Alexander with an army of 80,000 horses, 200,000 infantry, 2,000 four-horsed chariots and 3,000 to 4,000 elephants (Majumdar, 1943, pp. 44-45). This indicates a strong social organization and a well-advanced technology.

Agriculture was well established. Rural economy was centered in the village (grama) (Mookerjee, 1953, pp. 595-599). The village was surrounded by arable land (grama-kshetra) beyond which were the pastures. Arable land was divided into individual holdings but the grazing ground belonged to the community. The pasture was adjacent to the forest which supplied fuel and wood for the manufacture of the plow, pestle, mortar, implements, weapons, and carts (Idem).

**Gupta Dynasty (320-650 A.D.)**

Early in the 4th century, a mighty kingdom of the Gupta Dynasty was established in India and extended its territory into East Pakistan. The northern part (Gauda) of East Pakistan was directly under the Gupta kings; the eastern part (Vanga) was a tributary state. During this period the pace of Aryan immigration was accelerated and the Brahmanical Religion and caste system arose (Majumdar, 1943, p. 564). A gradual extension of cultivation and rural settlements continued during the Gupta period.

No information is available regarding land measures used in East Pakistan earlier than the 5th century A.D. Land grants of the Gupta period usually mention two technical terms, "kulyavapa" and "dronavapa". "Kulyavapa" signifies an extent of land which could be sown with seeds contained in a "kulya" (winnowing basket) and according to Parigter was a little larger than an acre (Majumdar, 1943, pp. 651-652). "Dronavapa" was one-eighth of a "kulyavapa". The length was measured by "nalas" which
ranged from six to nine cubits (cubit = eighteen inches).

Palas (715-1162 A.D.) and Senas (1162-1201)

For a century after the breakdown of the Gupta empire complete anarchy existed in East Pakistan. Small kingdoms were formed and little progress was made in any sphere of life. The country was consolidated and administration was stabilized in the beginning of the 8th century under the Pala kings. Pala rule is noted for the spread of Buddhism in East Pakistan. The caste system, however, though slightly weakened, was too deeply rooted to disappear completely.

The Palas were overthrown by the Senas in the middle of the 12th century but Sena rule lasted for less than fifty years (Ganguly, 1957, p. 39). Ascendance of the Sena king however, abolished Buddhism and established a caste system more rigid than those previously recorded in the history of East Pakistan.

The rights which the majority of farmers had to the land is unknown, but it is certain that all had to pay taxes and local assessments. In addition they were expected to supply provisions and labor for the army, the king and any high official visiting the locality. "Milk-money" was paid on the birth of a prince, marriage of a princess, or similar events (Majumdar, 1943, pp. 647-648).

"Nala" (six to nine cubits) continued to be the land measure, but the Sena Kings introduced variations in the actual length of "nala" which ranged up to fifty-six cubits. The length of "nala" also varied from region to region. Other important measures introduced by the Sena kings were "nala" and "khadra" which are still used in East Pakistan. Originally
a "nala" probably meant the extent of land that could be turned with a plow. "Khadra" was a smaller measure; twelve "khada" units made a "nala" (Ibid, pp. 653-654).

**Muslim Period (1201-1757)**

Before subjugating East Pakistan, the Muslims established their rule in the Indus and Upper Ganges Valley. From there Muslim merchants, traders, missionaries and travellers visited East Pakistan. Conquest of the province took place in 1201 A. D., by Mohammad Bakhtiar Khilji (Sirkar, 1948, p. 4). He was a Turk and brought with him his soldiers and their families. For about one century after Bakhtiar's conquest, the Muslim population consisted primarily of emigrants. It was during the rule of the House of Balbans (1286-1328) that Islamic missionaries became active and large numbers of the native population were converted (Ibid, p. 69).

In turn the Turks were suppressed by the Afghans in 1538. They continued to rule until 1578 when they were overthrown by the Moghuls. Many of the Afghans, thereupon, fled to the Sylhet area. Even today we find such historic Afghan names as Ghaznzvi, Pani, Yusufzai, and Sur, among the old landed proprietors (Ibid, pp. 187-188).

The Moghuls belonged to a branch of Turks (Chaghatai) named after the second son of Genghis Khan, the famous Mongol leader who ruled central Asia and Turkistan. Moghul rule brought peace to the province. Many people came from the heart of the Moghul empire to settle in East Pakistan. Maritime trade with Europe was well established since there was a ready demand in the European market for silk, indigo, and fine cotton goods. This naturally led to an expansion of indigo and cotton cultivation in East Pakistan (Ibid, p. 217).
Murshid Quli Khan, a revenue collector and later Governor of East Pakistan (1700-1716) introduced a number of changes in the land system. He appointed bonded contractors to collect land revenue; in the second or third generation these contractors were called zamindars (land lord). This practice initiated aristocracy in East Pakistan whose position was confirmed and made hereditary by Lord Cornwallis (Ibid, pp. 407-410). Khan also made a cadastral survey and gained accurate information concerning total areas that were cultivated, fallow, or barren. In addition, he prepared a comparative estimate of the past and present revenue yield of every rural unit (Ibid, p. 412).

British Period (1757-1947)

In 1498 Vasco da Gama, a Portuguese, circumnavigated the Cape of Good Hope and reached Calicut on the southwest coast of India. From then on European traders and travellers visited India in ever increasing numbers. Portuguese were the first to arrive and were followed by Dutch, English, Spanish, French and others. In 1600 the British East India Company was formed and trading privileges were obtained from the Moghul king. Bengal trade began in 1634 and a factory was established south of Calcutta (Fig.1) in 1640 (Hunter, 1886, pp. 364-368). British influence grew as the East India Company developed and the area of East Pakistan came under British rule in 1857. East Pakistan was first governed by the East India Company but was placed directly under the British crown in 1858 and remained under its control until 1947 (Ibid, p. 423).

Significant changes took place in the agricultural landscape of East Pakistan during British rule. Englishmen did not make East Pakistan
their home but ruled the land from abroad. They instituted the act of Permanent Settlement in 1793 and bestowed proprietary rights to the zamindars, similar to those of the landlords of England (Ibid, p. 439). The British were primarily interested in tropical crops for export. Indigo, which was introduced in East Pakistan in the middle of the 18th century, became an important crop to the British in the 19th century. Tea was brought from China by the East India Company in the 1830's (Hunterm 1909, p. 49) and its cultivation led to the establishment of plantation agriculture. Jute grew wild in East Pakistan and was used for the manufacture of gunny sacks, twine, and tope. After the British initiated the mechanical processing of jute in 1822 (Hayat, 1950, p. 3) its cultivation expanded.

Attempts were made during the British regime to apply scientific knowledge to agriculture. An Imperial Secretariate of Agriculture was established in 1880; an Agricultural Research Institute was initiated in 1905; and the Imperial Council of Research was formed in 1929 (Royal Commission for Agriculture, 1930, pp. 15-22). These agencies were organized to conduct agricultural research and to disseminate their findings. This resulted in the development of several new varieties of rice, jute, sugar cane, and other crops which were introduced into the agricultural complex. Chemically processed fertilizers were introduced but little progress was made in developing agricultural tools. Cadastral surveys were done agricultural statistics on a district basis were collected; and plot-to-plot surveys of all types of agricultural lands were made in 1944-45 (Ishaque, 1944-45).
Pakistan (Since 1947)

British rule over the Indo-Pakistan subcontinent ended August, 1947. British India and the Indian States were divided into two countries: Pakistan and India. In the new organization East Pakistan became a province of Pakistan. The improvement of agricultural practices is being encouraged in East Pakistan by international agencies and the government of the United States. Irrigation projects, agricultural research centers, and Village Aid programs are facets of the program.

Louisiana

Knowledge of agricultural practices in Louisiana prior to 1700 A. D. is very meagre. Archeological evidence indicates agriculture was probably being practiced by 800 B. C., and was definitely being practiced by 600 to 850 A. D. (Phillips, Ford, and Griffen, 1951, p. 454). However, little progress in agriculture above the dibble level was made until the arrival of the Europeans in 1700 A. D. The history of agriculture in Louisiana may be broadly divided into two periods, Indian and European.

Indians

Indians practiced a shifting slash-burn type of agriculture. Fields were prepared from lands covered with trees or cane which were cleared by burning (Kniffen, 1935, p. 5). Methods of cultivation were simple. Soil was truned with a hoe made from a tree limb or the shoulderblade of a buffalo. Seeds were sown with a planting stick which was a straight shaft pointed on one end (Kniffen, 1935, p. 5; Quimby, 1957, p. 159). Indians planted their fields on the bluff lands and river levees. Maize, beans, squash, and sunflower seeds were the main food crops and tobacco was produced for ceremonial purposes.
Indians lived in palmetto houses in the southern part of the state and in grass houses in the Red River area. A common feature of their dwelling was the granary. The Tunica Indians built their graneries off the ground on four posts which were fifteen to sixteen feet high. The granaries looked like dove-cotes and the posts were well polished, so that mice could not climb up (Swanton, 1911, p. 315). The granaries of the Natchez were round and were in the shape of a tower. The bottom was raised two feet above the ground and made of large whole canes. The inside was finished with cane mats and the outside was constructed of whole canes (Quimby, 1957, p. 154).

Colonial Period (1700-1803)

Hernandez De Soto led an expedition from Florida which reached Louisiana and the Mississippi River (Martin, 1882, pp. 34-79). His expedition was primarily in search of gold and his reported failure delayed the exploration of this region for 150 years. His party, however, left behind fowl and swine which multiplied in great numbers. Consequently, La Salle's party while descending the Mississippi River was supplied with fowl and pork by the Indians.

La Salle made two exploratory visits to Louisiana in 1678 and 1670 (Idem). In 1684 he planned to establish a settlement on the bank of the Mississippi River. However, he missed the mouth of the river and reached the coast of Texas, where he established a colony which later failed.

French interest in the colonization of Louisiana did not cease with the failure of La Salle's expedition. LeMoyne D'Iberville reached
the Gulf Coast of Louisiana in 1699 and established a settlement at the present site of Ocean Springs, Mississippi (Ibid., pp. 96-98). No substantial progress in agriculture was made for about twenty years after the establishment of the Ocean Springs settlement. The colonists were soldiers and explorers, and were interested primarily in trade, metals and adventure. Consequently they depended on the outside for their food supplies.

Bienville became the governor of the French settlements in 1718 (Ibid., pp. 125-130). He recognized that the prosperity of the colony depended on agriculture and that the alluvial soil along the Mississippi River was excellent farmland. The settlement established near the present site of New Orleans was designated as the capital of the colony.

The "Compagnie d'Occident," to whom the management of the colony was given in 1717, gave large grants of land to powerful and wealthy individuals. This led to the grandiose publicity schemes of John Law, who succeeded in introducing German agriculturists into the colony (Ibid., pp. 148-149).

The Germans settled along the Mississippi River in St. Charles and St. John the Baptist Parishes and demonstrated the great agricultural potentiality of Louisiana. They were industrious farmers and learned how to develop the primitive area. They used the hoe, spade, and pick-axe and cleared land by the same methods used by the Indians (Deiler, 1909, pp. 90-91). The chief subsistence crops were maize, rice, and beans. No extensive cultivation of wheat, barley, rye, and oat were undertaken (Ibid., pp. 56-59). Almost every house had a vegetable garden and the
produce was sold in New Orleans. Every Saturday evening, the Germans floated boat loads of vegetables, fowl and butter down the Mississippi River to New Orleans where it was sold on Sunday (Martin, 1882, p. 149). Germans led in agricultural enterprise in Louisiana but soon lost their individual identity and were assimilated into the French culture.

In 1784 the first group of uprooted Acadian French came from Canada. They were given land in the southwestern section of the state. Others continued to arrive in the state until 1785 and they settled along Bayou Lafourche and in the Parishes of Plaquemines, St. James, Iberville, and Pointe Coupee.

The closing years of the French rule were disturbing by political relations with England which culminated in 1758 in the Seven Years War. When defeated, France did not find it profitable to retain Louisiana and ceded the colony west of the Mississippi River and the Isle of New Orleans to Spain in 1763. During the Spanish regime a number of Spaniards came from the Canary Islands and settled below New Orleans on the Mississippi River, a small settlement on the Amite River and in the lower Bayou Teche area.

The French were interested in commercial products from the beginning. Tobacco and indigo were two important cash crops but both had almost disappeared by the end of the end of the colonial period. Sugar cane and cotton entered the agricultural complex of Louisiana during the French regime but did not gain importance then.

In his first expedition Iberville had brought a small number of cattle, hogs, poultry, and turkeys. The hogs multiplied but the cattle
remained few in numbers for about four decades. During that time cattle were imported from Cuba, San Domingo, Tampico, and Havana. Toward the end of the colonial period cattle herds had become quite extensive in central and southern Louisiana (Gray, 1941, pp. 78-80).

Plantation agriculture was established in Louisiana during the French rule. Its beginning was in the large concession granted the early settlers after 1717. It was then that large number of slaves were introduced. The number of slaves, however, was inadequate to cope with the labor requirements. Many of the concessions failed in the early years as a result of mismanagement, non-agricultural character of the settlers and unwieldy nature of land grants. Large concessions were thus broken into small private plantations of a self-sufficient nature. At the close of the colonial period Anglo-Saxon influence increased and sugar and cotton became staple crops of the area (Gray, 1941, pp. 329-335).

Territorial and Antebellum Period (1803-1860)

On December 20, 1803, the United States of America purchased 900,000 square miles of land from France in the "Louisiana Purchase". For nine years the area of Louisiana was under a territorial government. In 1812, it was admitted as the 18th state of the Union (Louisiana Legislative Council, 1955, pp. 32-41).

In 1803 nearly eighty per-cent of the state population lived along the Mississippi, Lafourche and Teche Rivers. The remainder was distributed in the Red and Ouachita River valleys and Florida Parishes. Northern Louisiana was sparsely populated until the 1830's and effective settlement was not accomplished until the annexation of Texas in 1845 and the
California gold rush in 1849. Many of the westward bound immigrants were attracted by the stands of Virgin pine, the abundance of game and the red color of the soil which they associated with great fertility. The most important ethnic group in the settlement of north Louisiana was the Scotch-Irish (Wright, 1956, pp. 19-22).

The Antebellum period is noted for an overall improvement of agriculture in Louisiana. Crop rotation was practiced and artificial fertilizers were used; agricultural implements were improved and standardized; and developments in transportation facilitated the movements of farm produce and thus helped the extension of agriculture.

Civil War and After (Since 1861)

The Civil War which started in 1861 lasted for about five years. The war retarded the agricultural development in Louisiana and the acreage of all crops except rice declined. Livestock was greatly developed and there was a shortage of farm implements and equipment. Many farm houses were destroyed and many more needed repair and there was little capital left to reconstruct the farms. Slavery was abolished and labor was not readily available (McGinty, 1935, p. 428). Not until 1900 was the cultivated acreage restored to the pre-Civil War level.

Another important effect of the Civil War was the influx of people from northern states. The migration was mostly to northern Louisiana and the Prairies. The open prairies especially attracted grain cultivators from the mid-west. Many settlers came from Illinois, Indiana, Nebraska, Iowa and adjacent mid-west states and brought new techniques of agriculture as well as new ideas about farm buildings.

Agriculture in Louisiana began to take more scientific shape in the
post-Civil War era. The U. S. Department of Agriculture, Agriculture Experiment stations, Farmer's Demonstration Work and other agencies began to disseminate scientific knowledge to the farmers (Williamson, 1940). The agricultural landscape changed rapidly particularly after World War I. Tractors and combines replaced mules and plows. Mules and horse sheds were changed to implement sheds. Telephones, hot and cold running water, refrigerators and automobiles became an integral part of the farmsteads.

**SUMMARY**

East Pakistan has been the cross-road for movements of people from South East Asia, the Mediterranean region and the Indus and Upper Ganges Valleys. Austric speaking people in the backwash from South East Asia probably started agriculture in East Pakistan in Neolithic times. They were responsible for dibble and hoe farming. The Dravidians who came next introduced plow agriculture. Aryans brought the caste system which divided the farmers into groups and probably laid the beginning of garden farming. The Mongoloids who appeared on the scene in the 7th century A. D. had dibble and hoe culture. They produced little effect on the general pattern of agriculture but some groups retained their culture and are still carrying on dibble and hoe farming. Muslim migrations in East Pakistan started in the early years of the 13th century. They introduced new land systems and extended cultivated acreage. European influences came last. They were responsible for a few new crops, introduced plantation agriculture and began scientific agricultural research. The agricultural landscape of East Pakistan, in spite of its long history, remains essentially the same as it was in the early years of the Christian era.
Agriculture in Louisiana was still in a rudimentary stage when the Europeans came in the early 18th century. Most of the crops cultivated today were either borrowed from the Indians or introduced by the French. The field patterns are suggestive of French, English and American influences.

Stagnation of agriculture in East Pakistan and its rapid progress in Louisiana are directly related to the settlement history of the two areas. East Pakistan is essentially inhabited by Archaic Caucasoids and Dravidians. The Aryans represent the upper class of the society and the caste system has kept a gulf between the two. Muslims were adept in administration and military technique but were not farmers. Englishmen were interested primarily in exploitation and did little to extend improvements in agricultural practices to the individual farmer. In 1904 the Agricultural Research Institute was established and since then significant work has been done. Efforts are being made to implement new techniques and change deeply entrenched traditions, but not much success has been achieved.

For centuries progress in agriculture was negligible in Louisiana, but once the European technological knowledge was available progress was rapid. Louisiana was then sparsely inhabited and the new settlers did not have to break through deeply rooted traditions. The Indians were acculturated in a few short years.
INSTITUTIONS AND ORGANIZATIONS

The entire agricultural complex of an area does not evolve locally, for some of the traits are borrowed from other areas. Generally, borrowed traits are selective. Usually only those traits are borrowed which conform to the value system of the people involved. The hog industry has little chance of development in East Pakistan since it is unacceptable to the Hindu and Muslim religions. Consolidation of holdings is not possible unless the law of inheritance is changed, or cooperative farming is practiced. It is, therefore, worthwhile to examine some of the important institutions of East Pakistan and Louisiana which affect the agricultural landscape.

Religion

Although religion is generally concerned with the spiritual side of human life, in societies where religion has a stronghold, its influences may also be reflected on economic patterns. This is true to an extent with the peoples of the Indo-Pakistan subcontinent. Two religious groups, the Muslims and the Hindus, are dominant in East Pakistan. Hinduism was introduced in the province in the early years of the Christian era and has flourished for centuries. Islam came in 1200 A.D. and attracted a large number of inhabitants within a century. Today 76.8 per cent of the population are Muslim, 22 per cent are Hindu, and the rest are Christian and Buddhist (Census of Pakistan, 1951, vol.3, table 6).

Islam, Hinduism and Buddhism impose certain taboos on food. Buddhists are prohibited from killing animals and eating meat. Hinduism
also imposes such restrictions on its adherents, particularly on eating beef, since the cow is a sacred animal to the Hindus. Certain low-caste Hindus, for example, "dora," eat meat from animals that die from natural causes. Muslims eat beef and also observe a festival in which cattle, goats and some other animals are sacrificed. Thus cattle, which served only as draft and dairy animals until the advent of Islam, began to be used as a source of meat and animals of sacrifice. To both the Muslim and the Hindu pork is taboo and consequently pig farms are absent in East Pakistan. The exception is the one in Dacca which was established to supply meat to pork eating people who are largely from other countries. A few pigs, however, are used for meat by low-caste Hindus and the hill tribes.

Louisiana is inhabited by Christians. Eating of both pork and beef is not taboo in the Christian way of life. Meat forms an important item of food and many cattle and pig farms are part of the landscape. These farms impart a distinct pattern to the agricultural landscape of the state.

Religion has played an important part in the fragmentation of holdings in East Pakistan. The law of inheritance was framed in accordance with the dictates of religion. According to Muslim law, property is divided among the husband and wife, sons and daughters. Consequently, even large holdings generally become small by the third generation. Hindu law recognizes only the sons as heirs and hence property is divided among fewer people. The division of property is sometimes delayed by the institution of joint family. In this system the eldest male becomes the
supreme authority of the family. Earnings of all members are added to a common fund and each member receives his share according to his needs. This is primarily practiced by the Hindus, but is not uncommon among the Muslims. The joint family is fast disappearing under the impact of European civilization.

The most manifest influence of religion on agriculture of East Pakistan is caused through the Hindu caste-system, a social stratification under divine sanction. Social stratification, though of a different nature, has also affected the agricultural landscape of Louisiana.

Social Stratification

The caste-system prevalent in the Indo-Pakistan subcontinent is of Aryan origin. It evolved in the northwestern part of the subcontinent, the hearth area or the "Holy Land" of the Aryans (Hunter, 1868, p. 94). According to Hindu belief, the Brahmans came from the mouth of Brahma or the Supreme Being; the Khatriya or the soldiers from His arms; the Vaisyas or the tillers of land from His thigh and the Sudras or the servile class from His foot (Risley, 1893, vol. pp. 141-142). Soon this class system separated into many subdivisions caused by intermarriage, illegitimate birth and loss of caste from nonobservance of rigid Brahmanical rules.

From the very beginning the caste-system was functional in character. Agriculture, as stated before, was originally the occupation of the Vaisyas. Later many of the Sudras took up farming, but for many years they worked as landless laborers. Brahmans, Khatriyas, Bhuyians, and other high castes own land, but never touch the plow. Kurmi is the main farming caste,
apart from Koch, Kapali, Chasadoba, Barui and others. Some castes are associated with a particular crop. Some have specialized in certain agricultural techniques. Thus the Baruis grow betel (Betel piper), and the Goala are the dairymen. Bunas and Bauris cultivate the towheads (Risley, 1893, vol. I, pp. 81 and 163) and the Silaris protect the crops from hail storms by magic.

The followers of Islam do not believe in the caste-system, but its adherents have not freed themselves completely from its influence. Though there is no religious stigma against the use of a plow, Muslim landlords, like the Brahmans, consider it below their dignity to touch the plow. Betel continues to be grown by the Baruis. Only in recent years have some Muslims taken up this pursuit (Ahmad and Khan, 1958, p. 1). The dairy industry is still the specialty of the "Goalas" and Muslims who are in this industry are called "Goalas."

The caste-system has produced visible imprints on the agricultural landscape. East Pakistan villages are divided generally into Muslim and Hindu sectors, demarcated by a road or "khal." The Hindu sector is divided into a number of hamlets belonging to different castes. The village of Paratala in Dacca district is an illustration (Plate VIII). All farmers in this village are Muslims who live in houses located in the middle of the village. The Hindus occupy the southern part of the village which is separated from the Muslim area by a road and farmland. The Hindus are not farmers but form an integral part to the agricultural complex. Farmers need blacksmiths (Kamars) for making and repairing plow blades, hoes, sickles, and other implements; carpenters (Shutra) for making plows,
harrors, hoe-handles, and so on; and boatmen (Patnis) to carry the farm products to the market across the river. These duties are performed by different Hindu castes, each one of them living in a separate hamlet.

From colonial days until the close of the Civil War (1865) the population of Louisiana comprised two classes, the freemen and the slaves. The slaves included Indians and Negroes. The Indian slaves were few in number and the practice did not last long because the French government was opposed to the policy of enslaving Indians. Most of the slaves were Negroes. They constituted the bulk of agricultural labor, particularly on plantations. Even today the Negroes play an important role as farm labor. In 1950, the total number of Negroes in Louisiana was less than 50 percent of the white population, but of the people engaged in agriculture the number of Negroes was almost equal to the whites (U.S. Census of Agriculture: 1950, vol. II, pt. 18, table 14).

Negroes are closely associated with plantation agriculture. In early colonial days, the plantation was a self-contained unit. Buildings consisted of a big house, for the owner or the manager, a row or rows of slave cabins, large barns, sheds, a church, and a store (Plate IX). Cotton plantations had cotton gins and sugar plantations had sugar mills. Large plantations also maintained hospitals. Even today the old set-up of the plantation has not been completely obliterated. Along the Mississippi River, some of the plantation owners or their managers still live in the 'big house' of the old days. A few relict slave quarters remain in the rural areas, mostly occupied by Negro laborers or tenant farmers.

On plantations there existed a considerable division of labor based
SCHEMATIC PLAN OF VILLAGE PARATALA, DISTRICT DACCA
SCHEMATIC PLAN OF THE COTTAGE PLANTATION, EAST BATON ROUGE PARISH
upon color, sex and age. The whites occupied the managerial posts as the stewards, bookkeepers, doctors and the like. Negroes did most of the manual tasks. Some of them held petty supervisory posts, like drivers who were in immediate charge of the laborers in the fields. Negro slaves were primarily divided into two classes: house and field servants. The field labor was organized into two systems: task and gang. Under the task system, the slave was assigned a certain amount of work for the day. Under the gang system, the slaves were divided into work groups, for example, plow gang, hoe gang, and so on. Each gang was put under the charge of a driver who either stood behind the line of slaves with a whip or led the gang and thereby set the pace of work. Olmstead has given a vivid description of the work force of a Louisiana cotton plantation on its way to the field (Olmstead, 1860, pp. 14-15):

"First came, led by an old driver carrying a whip, forty of the largest and strongest women I ever saw together; they were all in a simple uniform dress of bluish check stuff, the skirts reaching little below the knee; their legs and feet were bare; they carried themselves loftily, each having a hoe over the shoulder, and walking with a free powerful swing like chasseurs on the March. Behind them came the cavalry, thirty strong, mostly men, but a few of them were women, two of whom rode astride the plow mules. A lean and vigilant white overseer, on brisk pony, brought up the rear. The men wore small blue Scotch bonnets; many of the women handkerchiefs, turban fashion, and a few nothing at all on their heads."

The caste system and slavery have had a profound effect on the agriculture of East Pakistan and Louisiana, respectively. Under both systems the division of labor is well marked. In slavery no job was hereditary but some slaves performed the same duties over and over again because of their proficiency. In the caste-system an occupation is hereditary. Consequently, an agricultural class developed. That class
comprises castes engaged in general farming or some specialized agriculture. Each caste has a social circle of its own, so much so that members of the caste live in a separate hamlet. In Louisiana, the slaves lived in quarters at some distance from the white dwellings, but among the slaves no grouping and distinction was made.

There is another difference between the caste-system and slavery. Slavery was a social institution which crumbled under a social revolution, namely, the Civil War. The caste-system has divine sanction, and so the Hindu society has retained it in spite of efforts to outlaw it. Its impress on the agricultural landscape is still as vivid as it was centuries ago. In Louisiana the plantation landscape has changed considerably. The row of slave quarters has disappeared and in their place stand the houses of the sharecropper. There is no big house with its watchtower and there is no bell to call them to work. Many of the Negroes have become independent farmers and live on farms like their white neighbors. Because of the difference in social status the Negroes and whites usually live in separate parts of the settlement.

**Land Tenure**

Land tenure is of significant importance to the study of agricultural geography of an area. The relation of a farmer with the land, whether he is an owner or a tenant, is reflected in farm improvements and agricultural practices. Because of this relationship the system of land tenure in East Pakistan and Louisiana will be discussed.

East Pakistan was originally inhabited by nomadic collectors and hunters. The family then consisted of the mother and children. The father
or fathers of the children were inconstant members of the family, always ready to leave the family if they found more helpful comrades in some other group. This group of mothers and their children living together laid the foundations of permanent villages (Hewitt, 1897, p. 630). Even today the status of women as the first cultivators is recognized in the seasonal dances of the Mundas (Archaic Caucasoids) in which the sowing of seeds and preparation of the field for cultivation is done by the women.

The early villages with their cultivated fields were called "paras." There was no individual proprietorship in the "paras" and the produce belonged to the community (Hewitt, 1897, pp. 630-638). As the population increased villages began to grow in size, and small hamlets began to develop outside the main town. The headman lived in the parent village and exercised control over the hamlets. In this way large numbers of cultivated areas or "paras" were developed in East Pakistan by the time the Aryans came.

The Aryans introduced the concept of dividing the community into families (Hewitt, 1897, p. 638). Land held and tilled by a family was family property which could be inherited and sold. Thus the joint village of the early inhabitants gave way to a village of tenancy holders (raiyatwari village). The tenants were expected to pay a part of their harvest to the ruler. One-sixth of the grain lying on the threshing floor was recognized as the king's share or tax (Jather and Beri, 1949, vol. I, p. 342).

Muslim kings did not bring drastic changes in the tenure system. It was in the middle of the 18th century, about 350 years after the
Muslim conquest, that the tax in kind was changed to cash. A detailed survey of land type, cultivated area and crops grown was made (Moreland and Ali, 1918, p. 20). Four types of land were recognized: (1) land under continuous cultivation (polaj), (2) fallow land (parauti), (3) land out of cultivation for four or five years (cachar), and (4) land uncultivated for five years or more (banjar). The survey was done by the headman of the village and checked by the Revenue Officer (amalguzar). The assessment was conducted on the basis of produce; cash, valuing one-third of the produce, was collected for tax. This regulation system of assessment (zabti) is still practiced. Another system was called "nasaq"; instead of a detailed assessment an agreement was made with the cultivator. The rent was collected by the emperor's agent called zaminder. He was renumerated with a percentage of the collection or by an allotment of rentfree land. The zamindary then was an office and not a proprietary right to land (Haque, 1939, p. 215). The office gradually developed along hereditary lines, though formal sanction of the emperor was required in every case.

Revenue collection of East Pakistan was handed over to the British East India Company in 1765, and in 1793, the Act of Permanent Settlement was established. Under this act the zamindars were declared full proprietors of areas over which their revenue collection extended (Land Revenue Commission, 1940, vol. I, p. 18). Farmers also had perpetual hereditary and transferable rights over the land. Thus a dual ownership was established that of cultivation. Most lands of East Pakistan are now held under
permanent settlement. Small areas are either temporarily settled for a period of fifteen to twenty years, are rent free or are controlled by the State (Table 7).

**Table 7**

**EAST PAKISTAN LAND OWNERSHIP**

<table>
<thead>
<tr>
<th>Category</th>
<th>No. of Estates</th>
<th>Area</th>
<th>Proportion of total area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Million Acres</td>
<td>Per cent</td>
</tr>
<tr>
<td>Permanently settled</td>
<td>94,000</td>
<td>37.37</td>
<td>80</td>
</tr>
<tr>
<td>Revenue free</td>
<td>51,000</td>
<td>1.97</td>
<td>5</td>
</tr>
<tr>
<td>Temporarily settled</td>
<td>4,000</td>
<td>3.34</td>
<td>7</td>
</tr>
<tr>
<td>Government-owned</td>
<td>4,000</td>
<td>3.65</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>153,000</strong></td>
<td><strong>46.33</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Source: Indian Society of Agricultural Economics, Land Tenure in India, 1946, Appendix II, p. 70.

In permanently settled areas, the State was entitled to a fixed revenue from the zamindars which was equivalent to about nine per cent of the total rent collected from the tenants in 1793. The zamindars were entitled to enhance the rents under certain conditions and they took full advantage of the privilege. Consequently a divergence began to grow between the fixed revenue paid by the zamindars and the rent paid to the zamindars. This brought about a process of sub-infeudation of the zamindar's interest below him and even below the tenants in some cases. In the course of time this sub-infeudation reached fantastic proportions in some districts. In the district of Bakarganj, for example, the number of these
intermediate classes was normally fifteen to twenty (Bengal Land Revenue Commission, 1940, pp. 33-37). The Simon Commission reported that in some districts the number rose to fifty. Five main agricultural classes are recognized in East Pakistan:

1. Zamindars (Landlords): The tenure holder who acquires land for purposes other than cultivation and is only entitled to rent from the land.

2. Raiyat (tenant): Rents land from the zamindars for cultivation.


4. Bargadar (sharecropper): Cultivates the land of the zamindar or the raiyat on basis of sharing expenses. He has no right to the land.

5. Landless labor: Works for wages.

The zamindars and the intermediaries were interested only in rent and not in land. Some of them lived permanently in cities and occasionally visited the village; those who lived in the village were indifferent to what was going on around them. The farmers were usually too poor to invest in farm improvements. They owned small parcels of land from which they barely scratched their living, and most of them were illiterate and quite ignorant of modern farming practices. Under such circumstances agriculture in East Pakistan has been primarily exploitative. Zamindary was abolished by the Tenancy Act of 1951. Cultivators now have to pay the rent directly to the State. Rent paid by the farmers can be used for
agricultural improvements and is not distributed among the zamindars and the intermediaries,

The concept of land ownership is a European introduction in the New World. Indians did not have this concept of ownership; they recognized the right to use land, but did not practice either land inheritance or transfer.

The European settlement of Louisiana was started in 1700 by the French. Large grants of land called concessions were made to individuals and companies. The concessions were planning to carry on agriculture and establish manufacturing. Some of them were like John Law and were thinking of keeping troops and founding duchies. The concessions were short-lived and disappeared without any substantial accomplishments. Many settlers were granted small holdings; from south of Baton Rouge to the Gulf of Mexico small grants of two to three arpents were given to the families of workmen and discharged soldiers (Martin, 1882, p. 172). The Acadians were also granted small holdings. In 1770, the Spanish initiated the policy of granting to each family six to eight arpents frontage on the Mississippi River and forty arpents in depth. In the Florida Parishes the English allotted 100 acres per person. By the close of the colonial period the headright policy was introduced which allowed 200 acres to each man and his wife, fifty acres for each child and twenty acres for each slave. It was the headright policy which led to the establishment of large plantations. Men with resources could buy slaves and secure large grants of land for establishing plantations. In 1803, when Louisiana became a part of the United States, the General Land Office system was introduced
Land was sold by townships and sections at public auction. There was no limit set to the amount of land purchased by an individual and easy credit facilities helped the purchase of large tracts. Plantations, thus, became more widespread.

Tenancy started during colonial times. Bienville divided his lands into small holdings and rented them to small cultivators (Cruzat, 1918, vol. I, p. 123). In all probability, the number of tenants dropped after Louisiana became a part of the United States. Poor whites got the opportunity to purchase land under easy credit terms but Negroes could not become tenants (Gray, 1941, vol. II, p. 646). The Civil War brought a great change in the system of land tenure. Slavery was abolished and tenant farming became widespread; various tenant systems are still in use today (Tatum, 1939, pp. 4-6).

**Cash-tenants:** pay a specified amount of rent per acre or per farm to the landlord. The produce and the expenditure on production is theirs.

**Standing renters:** similar to cash-renter except that they pay the landlord a specified amount of farm products.

**Share-cash tenants:** pay part of the rental in cash and part in kind.

**Share-tenants:** pay a specified part of the crop, as one-fourth, one-third or one-half, and own their workshops and tools.

**Sharecroppers:** farm laborers who receive a share of the crop in return for their labor and that of their families.

The most common arrangement is that the tenant
Sharecropper, cont'd.: receives half the produce and invests half the expenditure.

Louisiana tenants have no right to the land. The lease is commonly year-to-year (President's Committee, 1937, p. 49); less commonly, the lease is made for three to five years. Tenancy is unstable and the tenant farmer is slow to make farm improvements (Hoffsommer, 1950, pp. 208-210), particularly since he gets no compensation for improvements under existing laws (President's Committee, 1937, p. 50). Tenants practice contour plowing but do not build terraces or other permanent types of water holding and soil saving structures. Owner-operators practice more diversification, keep more livestock and grow more legumes than tenant farmers. As a group, owner-operators are more conservative than the tenant group. The number of tenants in Louisiana continued to increase until 1935 but is now decreasing; from 1935 to 1950 the numbers have decreased by fifty per cent (Montgomery, 1952, p. 7). In contrast, the tenants in East Pakistan should have taken greater care of the land because of a more permanent character of tenancy. The zamindary system and sub-infeudalism left little surplus for the actual tillers of the land to make improvements. Small holdings and ignorance contributed to the general farm neglect.

Government and Agriculture

Governments are taking an active interest in the agriculture of Louisiana and East Pakistan today. They act as advisors to the farmer and at times take strong measures to implement useful programs.

Until 1880 in East Pakistan the State's only interest in land was
the collection of revenue; then the Provincial Agricultural Department was established under the recommendation of the Famine Inquiry Commission. In 1905 the Department was entrusted with agricultural research and demonstration. Subsequently Imperial Institutes of veterinary research, animal industry, cane breeding and others were established in various centers of the Indo-Pakistan subcontinent including East Pakistan. The Imperial Council of Agricultural Research was founded in 1929 to act as a clearing house for agricultural information.

With the creation of Pakistan in 1947, all the centers of Imperial Institutes including the Imperial Research Council remained in India. East Pakistan had one agricultural college and one experiment farm. A college for animal husbandry was established immediately after independence and since then a Jute Research Institute at Dacca, a Tea Research Station at Srimangal, a Sugar Breeding Station near Lalpur and a Jute Farm in the Kushta District have been developed (Fig. 1). Twenty farms of 100 acres each and two farms of 3,000 acres each are to be established by 1960 for growing seed other than jute, and two farms of 400 acres each are being established for jute seed (Planning Board, 1956, vol. II, p. 32). Under a plan initiated in 1949 the farmers are supplied with manure and fertilizer at fifty per cent subsidy and free service for plant protection is now available. At Partition cold storage facilities which were used particularly for seed potatoes remained in India. The absence of storage facilities resulted in the absence of potato seed and consequently acreage decreased by more than fifty per cent from 1947 to 1951. In the Five Year Plan, provisions have been made for the construction of cold storage
warehouses at Dacca, Santahar (near Bogra) and Chittagong (Fig. 1). The
government is taking an active part in farming practices in the province
and the agricultural landscape is likely to undergo a marked change.

From the early days of colonization, the U.S. government has
been concerned about agriculture in Louisiana. Apart from collecting taxes
from the farmers and planters, the government was instrumental in the
introduction of plants and agricultural implements. Levees along the
Mississippi River were constructed by the governing body and at times
monetary help was given to new settlers. In general the government
encouraged the agricultural enterprise of the state.

The United States government became more actively interested in
the agriculture of the nation in 1862, and established the Department of
Agriculture; "Land grant colleges" were authorized in every state (Nourse,
1940, p. 872). However, Louisiana was then in the Civil War, so it
could not profit by the Act. It was not until 1874 that an Agricultural
College was established in the state. Since 1885 a number of agricultural
experiment stations have been established in different parts of the state
to conduct research on plants, livestock breeding, plant and animal diseases,
fertilizers, water requirements and social and economic implications of
agriculture. Results of the research work are communicated to the
farmers by the Extension Service established in 1914. Prior to that time,
Farmers' Institutes, Farmers' Cooperation Demonstration Work, and various
Boys and Girls' Clubs were instrumental in disseminating the results of the
research. The extension program today is well organized and an individual
farmer can call upon the county agent for help and guidance. The county
agent benefits from the traveling extension specialists who remain in close touch with experiment stations.

Acreage of several crops in Louisiana today is controlled by the government. After World War I, a surplus of agricultural products was created in the United States and the problem became more acute during the depression of the 1930's. The price of commodities dropped and the farmers were unable to sell their crops. To cope with the problem the government passed the Agriculture Adjustment Act in 1938 (Nourse, 1940, p. 913). The Act controlled production of nine basic commodities: cotton, wheat, rice, tobacco, hogs, dairy products and others (Nourse, Davis, and Black, 1937, p. 57). In 1936 the Soil Conservation and Domestic Allotment Act was passed which shifted the emphasis from the control of production to the conservation of soil resources. Farmers were induced to plant soil-conserving crops instead of soil depleting crops. Further changes in the agricultural picture resulted from the Soil Bank Act of 1956. Under this act, farmers are encouraged by compensation payments to underplant their acreage allotments of cotton, rice, corn and wheat and put them under forage crops like hay, alfalfa and clover (Gile, 1956, p. 3). Thus the distributional picture of crops in Louisiana today is controlled to a considerable extent by the government. The increasing number of livestock and expanding acreage of forage crops in the Red River Valley, Prairie region and Florida Parishes are partially explained by acreage allotments and Soil Bank activities.

Active participation of the government in the agricultural enterprises of East Pakistan may be said to have started in 1880 with the
establishment of the Provincial Department of Agriculture and in Louisiana since the beginning of colonization. Since then the two governments have been increasingly interested in the agriculture of their respective areas. Efforts in Louisiana have borne fruit and the agricultural landscape has undergone revolutionary changes but conditions in East Pakistan remain about the same. Pakistani farmers are verbally informed about improved agricultural practices and this method has proved ineffective in all countries of the world. Demonstration, when conducted, is on government farms and the farmer does not have the same facilities to work with. East Pakistan does not have 4-H clubs, agricultural fairs nor well organized extension services. A gap exists between research workers and farmers. Agricultural research is an academic pursuit with little practical applicability. Until this gap is bridged by practical field demonstration, the agricultural landscape will change very little.

International Agencies

Through the modern communication systems, agricultural knowledge gained in one country is diffused easily to other countries. Various international agencies are organized to cooperate in world-wide agricultural developments, particularly in underdeveloped countries. East Pakistan is getting technical advice and financial aid from the International Cooperation Agency, the Point-Four Program, the Colombo Plan and others. Village aid centers have been established near Khulna, in Rangpur District, at Dacca and Comilla to teach the farmer better agricultural practices. Grain storage facilities and seed multiplication farms are in the planning stage. Immediate changes in the agricultural landscape will likely result from
irrigation projects which are being developed. It will then be possible to increase the acreage of winter crops.

Rapid means of transportation have led to the development of a world market. However open competition has proven disastrous to several crops and international controls on production are exercised. Tea and sugar cane are examples.

A major disturbance in the tea market took place during World War I. Production exceeded the demand and prices dropped. In 1920-21 efforts were made to control production and export but the efforts failed. The world depression of the 1930's increased the need for control and in 1933 the International tea agreement was signed. According to the agreement each participating country is allocated export and acreage quotas. According to the agreement of 1948, Pakistan which is a participating country was allocated 76,700 acres which could be raised to 79,768 by 1955 (Wickizer, 1951, p. 242). All tea gardens of Pakistan are located in the province of East Pakistan. Expansion is possible but certain limits have already been noted. The distribution of tea in East Pakistan, like that of jute, is controlled by various institutions.

Sugar cane acreage of Louisiana, like the tea acreage of East Pakistan, is subject to international agreements. These are necessary because of the increased development of the sugar beet industry after World War I and an overproduction of sugar cane caused by the introduction of a new variety of cane, POJ 2878 (Geerlings, 1931, p. 137). The first agreement was signed in 1931 but did not prove to be a great success. In 1937 a new agreement was negotiated among twenty-two nations which included
the important producing and consuming countries. This agreement was renewed in 1953. The provisions of these agreements are implemented by the Sugar Acts of the United States and therefore sugar cane production of Louisiana is controlled not by the farmers, but by international commitments of the government.
Marked differences are noticeable in the population characteristics of East Pakistan and Louisiana. East Pakistan is densely populated; 95.7 per cent of the population is rural and 81.9 per cent of the labor force is engaged in agriculture (Census of Pakistan, 1951, vol. III, pp. 57). In comparison Louisiana is sparsely populated; less than fifty per cent of the population is rural and only 17.3 per cent of the labor force is engaged in agriculture (U. S. Census of Population, 1950 vol. II, tables 1 and 30). These differences in the characteristics of population explain partially the differences in the agricultural practices of East Pakistan and Louisiana.

Little is known about the population of East Pakistan before 1871 when the first official census was taken. However, some rough estimates can be made about the number of inhabitants prior to 1871. It is reported that the people of Bengal were ready with 8,000 horses, 200,000 infantry, 2,000 four-horse chariots, and 3,000 elephants to fight Alexander the Great in 326 B.C. (Majundar, 1943, pp. 44-45). Assuming there was one soldier for every horse, four per chariot, and two for each elephant, the total number of the army would be 224,000 men. If the ratio of civilians to soldiers was the same as that of France and Germany during World War I (Davis, 1951, p. 24), the population of Bengal would be 6.7 million some 2300 years ago. The population of East Pakistan continued to grow and by 1881 was 25 million. Since then a rapid increase in population is noted (Table 8). By 1951 the number had increased to forty-two million. Table 8
shows an abrupt rise in the population between 1931 and 1941 and only a slight increase between 1941 and 1951. This is the result of an unreliable census in 1941. At that time political passions were running high and both Hindus and Muslims tried to inflate their figures.

Prior to the arrival of the Europeans in 1700, little is known of the number of inhabitants in Louisiana. The Indians then probably numbered 13,000 (Kniffen, 1935, p. 12). During the early years of colonization population increase was slow; after eighteen years of settlement, European population was 700. Through the efforts of John Law of Compagnie de Occident the population increased to 7,700 by 1720 (Gray, 1941, pp. 64-65). German immigrants from Law's concession settled in St. Charles and St. John the Baptist parishes and demonstrated the potential possibilities for the small farmer in Louisiana. In 1758, about 4,000 French Acadians migrated to Louisiana from Canada. By 1803 the population of Louisiana had increased to 60,000 (McGinty, 1951, p. 162). Rapid rise in population continued and in no decade was the increase less than thirty-five per cent until the Civil War (U. S. Census of Population, 1950, vol. II, pt. 18, table 1). The lowest increase (2.7 per cent) was recorded between 1860 and 1870 during the Civil War. The population continued to increase after the Civil War but the rate of increase never reached the pre-Civil War level. In 1870 the population was 726,915 and by 1950 it rose to 2,683,516. The population of East Pakistan in 1951 was 42.0 million.
TABLE 8
Population Density and Increase in East Pakistan and Louisiana

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
<th>Increase</th>
<th>Persons Per Sq. Mile</th>
<th>Year</th>
<th>Population</th>
<th>Increase</th>
<th>Persons Per Sq. Mile</th>
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<tbody>
<tr>
<td>1881</td>
<td>25,086,000</td>
<td></td>
<td>456</td>
<td>1880</td>
<td>939,946</td>
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<td>20.8</td>
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<tr>
<td>1891</td>
<td>27,103,000</td>
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<td>493</td>
<td>1890</td>
<td>1,118,588</td>
<td>19.0</td>
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<tr>
<td>1901</td>
<td>28,928,000</td>
<td>6.7</td>
<td>527</td>
<td>1900</td>
<td>1,381,625</td>
<td>23.5</td>
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</tr>
<tr>
<td>1911</td>
<td>31,555,000</td>
<td>9.0</td>
<td>582</td>
<td>1910</td>
<td>1,656,388</td>
<td>19.9</td>
<td>36.6</td>
</tr>
<tr>
<td>1921</td>
<td>33,254,000</td>
<td>5.3</td>
<td>612</td>
<td>1920</td>
<td>1,789,509</td>
<td>8.6</td>
<td>39.8</td>
</tr>
<tr>
<td>1931</td>
<td>35,604,000</td>
<td>7.0</td>
<td>667</td>
<td>1930</td>
<td>2,101,593</td>
<td>16.9</td>
<td>46.3</td>
</tr>
<tr>
<td>1941</td>
<td>41,997,000</td>
<td>17.9</td>
<td>775</td>
<td>1940</td>
<td>2,363,880</td>
<td>12.5</td>
<td>52.3</td>
</tr>
<tr>
<td>1951</td>
<td>42,063,000</td>
<td>.1</td>
<td>777</td>
<td>1950</td>
<td>2,683,516</td>
<td>13.5</td>
<td>59.4</td>
</tr>
</tbody>
</table>


Pressure on Land

Progressive population gains of East Pakistan increased demand on the land. In 1881 the density of population was 456 persons per square mile; by 1951 it rose to 777 (Table 8). If 5007 square miles of the rugged sparsely populated Chittagong Hill Tracts are excluded, the density rises to 857 persons per square mile which makes East Pakistan one of the most densely populated areas of the world for its size. When only the cultivated area is taken into consideration (Plate X A) the density rises to 1211 per square mile. Not all people live off the land but this
makes little difference in an area where industrial development is insignificant and urban population is only 4.3 per cent (Table 9). Subsistence farming supports the bulk of East Pakistan's population.

TABLE 9

Urban and Rural Population Percentages in East Pakistan and Louisiana

<table>
<thead>
<tr>
<th>Year</th>
<th>Urban</th>
<th>Rural</th>
<th>Year</th>
<th>Urban</th>
<th>Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1891</td>
<td>Not Available</td>
<td>Not Available</td>
<td>1890</td>
<td>25.4</td>
<td>74.6</td>
</tr>
<tr>
<td>1901</td>
<td>2.5</td>
<td>97.5</td>
<td>1900</td>
<td>26.5</td>
<td>73.5</td>
</tr>
<tr>
<td>1911</td>
<td>2.6</td>
<td>97.4</td>
<td>1910</td>
<td>30.0</td>
<td>70.0</td>
</tr>
<tr>
<td>1921</td>
<td>2.6</td>
<td>97.4</td>
<td>1920</td>
<td>34.9</td>
<td>65.1</td>
</tr>
<tr>
<td>1931</td>
<td>3.0</td>
<td>97.0</td>
<td>1930</td>
<td>39.7</td>
<td>60.3</td>
</tr>
<tr>
<td>1941</td>
<td>3.6</td>
<td>96.4</td>
<td>1940</td>
<td>41.5</td>
<td>58.5</td>
</tr>
<tr>
<td>1951</td>
<td>4.3</td>
<td>95.7</td>
<td>1950</td>
<td>50.8</td>
<td>49.2</td>
</tr>
</tbody>
</table>


When smaller areas are considered pressure on the land is more discernible. In Dacca and Tippera Districts, 1942 and 1500 persons respectively, live in a square mile; density of farm population per square mile of cultivated land rises to 1700 and 1900, respectively. The police stations along the Meghna River in Tippera and Dacca Districts comprise an area of 1656 square miles, of which 1033 square miles are cultivated (Ishaque, 1946, pp. 94-103). In that area 2,600 persons live per square mile of cultivated land. There are areas of comparatively
EAST PAKISTAN
FARM POPULATION PER SQUARE MILE OF FARM LAND

SOURCE OF DATA: AGRICULTURAL STATISTICS
BY PLOT-TO-PLOT ENUMERATION IN BENGAL,
1944-45
Louisiana

Farm Population per Square Mile of Farmland

Source: U. S. Census of Agriculture, 1950
U. S. Census of Population, 1950
less density, however. In the Khulna District density is 432 persons per square mile, and Chittagong Hill Tracts District, fifty-seven persons per square mile (Census of Pakistan, 1951, Table 1). These districts include large uncultivated areas; the southern part of Khulna District is covered with mangrove swamps and the major part of Chittagong Hill Tracts is mountainous.

In contrast to East Pakistan, Louisiana is sparsely populated. There were 59.4 persons per square mile in 1950. If only farm land and farm population are considered, population density increases to 30 persons a square mile. According to the 1950 census, the farm population of Louisiana was 571,421 (U.S. Census of Population, 1950, vol. II, table 13) and the area of farm land was 17,503 square miles (U.S. Census of Agriculture, 1950, vol. I, part 24). Farm population density per square mile of farm land is 32.6 persons. Population distribution on the farms is not equal over the whole state. Vegetable and fruit growing parishes like Livingston and Tangipahoa, and sugar cane producing parishes like Lafayette and West Baton Rouge have higher population densities than those where cattle raising is important (i.e., Cameron, Vermilion, Jefferson Davis and others) (Plate X B).

No Louisiana parish has more than 75 persons living on one square mile of farm land, whereas in East Pakistan no district has less than 500 persons per square mile of farm land. This difference in the pressure on land is reflected in the agricultural practices of the two areas.

Agricultural Pattern

Because of the high density of population East Pakistan farms
are small; ninety percent are smaller than 10 acres (Table 10). Each farmer presently cultivates an average of 2.07 acres of land, compared with 72.2 acres in Louisiana (Census of Pakistan, 1951, vol 3, Table II; U. S. Census of Population, 1950, Table 30). If agriculture in East Pakistan became mechanized on the scale of Louisiana, 10.2 million agricultural workers out of 10.7 millions would have to seek employment elsewhere. Even if each worker had 20 acres, which is supposed to be an economic holding for that part of the world (Jather and Bari, 1949, p. 184), 8.5 million workers would have to quit farming. In view of the slow growth of industry, employment off the farms is not available. Technological advancement in farming must be accompanied with similar development in industries; otherwise the cultural lag in one will hamper the progress of the other.

**TABLE 10**

Farm Size: East Pakistan and Louisiana

<table>
<thead>
<tr>
<th>Size of Farms</th>
<th>Total Number of Farms</th>
<th>Percent of Total</th>
<th>Total Number of Farms</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2 acres</td>
<td>5,671</td>
<td>50</td>
<td>Under 10 acres</td>
<td>15,010</td>
</tr>
<tr>
<td>2-3 acres</td>
<td>1,273</td>
<td>11</td>
<td>10-49 acres</td>
<td>68,170</td>
</tr>
<tr>
<td>3-4 acres</td>
<td>1,045</td>
<td>9</td>
<td>50-99 acres</td>
<td>20,150</td>
</tr>
<tr>
<td>4-5 acres</td>
<td>817</td>
<td>7</td>
<td>100-179 acres</td>
<td>10,222</td>
</tr>
<tr>
<td>5-10 acres</td>
<td>1,698</td>
<td>15</td>
<td>180-259 acres</td>
<td>3,568</td>
</tr>
<tr>
<td>Over 10</td>
<td>807</td>
<td>8</td>
<td>260-999 acres</td>
<td>5,580</td>
</tr>
<tr>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
<td>1000 acres and over</td>
<td>1,322</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm Population</th>
<th>Farm Labor</th>
<th>Land in Farm</th>
<th>Average Size of Farm</th>
<th>Number of Tractors</th>
<th>Number of Mules and Horses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>784,455</td>
<td>10,019,822</td>
<td>74.0</td>
<td></td>
<td>2,812</td>
<td>358,871</td>
</tr>
<tr>
<td>1925</td>
<td></td>
<td>8,837,502</td>
<td>66.7</td>
<td></td>
<td>3,482</td>
<td>304,827</td>
</tr>
<tr>
<td>1930</td>
<td>826,882</td>
<td>9,355,437</td>
<td>57.9</td>
<td></td>
<td>5,016</td>
<td>319,394</td>
</tr>
<tr>
<td>1935</td>
<td></td>
<td>387,775</td>
<td>61.4</td>
<td></td>
<td></td>
<td>320,106</td>
</tr>
<tr>
<td>1940</td>
<td>850,382</td>
<td>259,100</td>
<td>9,996,108</td>
<td>66.6</td>
<td>9,476</td>
<td>317,282</td>
</tr>
<tr>
<td>1945</td>
<td>853,949</td>
<td>184,847</td>
<td>10,039,657</td>
<td>77.6</td>
<td>17,630</td>
<td>293,226</td>
</tr>
<tr>
<td>1950</td>
<td>594,127</td>
<td>189,717</td>
<td>11,202,278</td>
<td>90.2</td>
<td>35,735</td>
<td>233,288</td>
</tr>
<tr>
<td>1954</td>
<td>571,420</td>
<td>283,475*</td>
<td>11,441,343</td>
<td>103.0</td>
<td>47,929</td>
<td>144,907</td>
</tr>
</tbody>
</table>


* for October--November
A significant correlation exists between the density of population and the intensity of land use. In the Barisal Subdivision of Bakarganj District, the Sadar Subdivision of Noakhali District and the Chandpur Subdivision of Tippera District (Fig. 1), where population density is 1133, 1386 and 1548 persons per square mile, respectively, (Census of Pakistan, 1951, vol. 3, Table 1-2), betel-nut gardens are most numerous. In Rampal, Rakabi Bazar, Panchasher and Munshiganj Unions in the southern part of Dacca District, more than 5,000 persons live on a square mile and garden farming is intensively practiced (Khan, 1957, p. 97).

Direct correlation between density of population and mechanization of agriculture is difficult to establish in Louisiana. Compared to East Pakistan, Louisiana has always been sparsely populated. If sparse population alone induces mechanization, Louisiana would have adopted tractors, combines and other implements immediately after World War I, when large scale mechanization started in many other states. In Louisiana World War I marked only the beginning and large scale mechanization awaited World War II (Table 11), when an acute shortage of labor was felt. Wages increased; young people joined the armed forces; and aged and retired people began farming (Table 12). High prices for agricultural produce made capital available and investment in machinery profitable. Ease of work desired by the aged was also an important factor in farm mechanization. Mechanization would not have been possible, however, if other cultural elements were unfavorable. Large farms are a prerequisite for extensive use of farm machinery. The large size of the average Louisiana farm (Table 10) is partly attributable to sparse
population. In this indirect way population becomes one of the determinants in the mechanization of farms in Louisiana. Although most of the farms of Louisiana are large enough to use tractors, not all of them are mechanized. Some conservative farmers like the old system; some can not afford machinery; and still others think themselves too old to change (Bertrand, 1951, p. 19). The last reason is particularly interesting. To some old age is the motivation for mechanization, while for others it becomes the chief reason for retaining customs.

**TABLE 12**

**Age of Louisiana Farm Operators**

<table>
<thead>
<tr>
<th>Age</th>
<th>1920</th>
<th>1930</th>
<th>1940</th>
<th>1950</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>Per cent</td>
<td>No.</td>
<td>Per cent</td>
</tr>
<tr>
<td>Under 25</td>
<td>12,183</td>
<td>9.1</td>
<td>17,824</td>
<td>11.4</td>
</tr>
<tr>
<td>25-34</td>
<td>29,473</td>
<td>22.0</td>
<td>33,958</td>
<td>21.7</td>
</tr>
<tr>
<td>35-44</td>
<td>35,442</td>
<td>26.4</td>
<td>37,205</td>
<td>23.8</td>
</tr>
<tr>
<td>45-54</td>
<td>29,873</td>
<td>22.3</td>
<td>34,516</td>
<td>22.0</td>
</tr>
<tr>
<td>55-64</td>
<td>16,626</td>
<td>12.4</td>
<td>21,663</td>
<td>13.8</td>
</tr>
<tr>
<td>65 and over</td>
<td>10,436</td>
<td>7.8</td>
<td>11,403</td>
<td>7.3</td>
</tr>
</tbody>
</table>


**SUMMARY**

East Pakistan is thirteen times more densely populated than Louisiana; considering the density of farm population to farm land, it is seventeen times more densely populated. Each agricultural worker
in East Pakistan has an average of 2.07 acres to cultivate, while his counterpart in Louisiana has an average of 72.2 acres. This situation has encouraged mechanization in Louisiana and made it impracticable in East Pakistan. To support a heavy population, intensive farming is necessary. Though agricultural practices of East Pakistan are crude the farmer supports his family on his small acreage.

**TABLE 13**

Crude Birth and Death Rates and Natural Increase of Population in East Pakistan and Louisiana

<table>
<thead>
<tr>
<th>Year</th>
<th>Birth Rate Per 1000 Persons</th>
<th>Death Rate Per 1000 Persons</th>
<th>Natural Increase Per 1000 Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>East Pak.</td>
<td>Louisiana</td>
<td>East Pak.</td>
</tr>
<tr>
<td>1911</td>
<td>35.5</td>
<td>available</td>
<td>32.5</td>
</tr>
<tr>
<td>1921</td>
<td>32.5</td>
<td>available</td>
<td>31.1</td>
</tr>
<tr>
<td>1931</td>
<td>28.5</td>
<td>20.3</td>
<td>25.3</td>
</tr>
<tr>
<td>1941</td>
<td>22.8</td>
<td>9.8</td>
<td>13.0</td>
</tr>
<tr>
<td>1949</td>
<td>11.80</td>
<td>28.6</td>
<td>8.59</td>
</tr>
</tbody>
</table>


High population density in East Pakistan is often attributed to a high birth rate. Louisiana actually has a higher increase rate considering both births and the influx of new people (Tables 8 and 13). It is the difference in total population which makes East Pakistan increase more
rapidly. The difference in absolute numbers is the result of the different cultural history of the two areas. Technologically, East Pakistan had advanced sufficiently to support a large population in 326 B.C., whereas only 13,000 people lived in Louisiana in 1700. In 1881 East Pakistan had a population of twenty-five million; Louisiana's population numbered ninety-four thousand. It is this initial wide gap in the number of inhabitants which accounts primarily for the present-day differences.
Agricultural practices of Louisiana and East Pakistan exhibit marked contrasts. Plow agriculture dominated the major part of both areas, but there the similarity ends. Louisiana agriculture is mechanized; in East Pakistan, age-old methods and implements are used. Two distinct types of farming are practiced; dibble farming in Chittagong Hill Tracts and plow tillage in the remainder of the province.

**Dibble Farming**

Dibble farming is one of the most primitive types of agriculture. It was utilized by Louisiana Indians for centuries before the Europeans came; after the introduction of the plow, dibble farming soon disappeared. Dibble farming (jhuming) was prevalent in East Pakistan during Neolithic times and is still practiced by tribesmen in the Chittagong Hill Tracts.

During January or February, the dibble farmer selects a convenient plot of hillside forest land and clears it of shrubs and creepers by the slash-burn method. Small trees are felled and large trees are denuded of their lower branches and left standing. A slope thickly covered with bamboo is preferable because it is more easily cut and bamboo ashes are more fertile. The cuttings are allowed to dry in the sun until the first part of April when they are burned. The fire reduces all but the large trees to ashes. When the field is cleared of charred logs it is ready for planting. Land clearing is done on a communal basis and is divided among families for tilling. Each family cares for about two acres of land.
Sowing begins in late April or early May. Men, women, boys and girls bind on their left hips a small basket filled with the mixed seeds of rice, maize, cotton, melons, pumpkins and yams. The family forms a line and steadily works its way across the field. A few mixed seeds are planted in holes about three inches deep which have been made with a digging stick or hill knife (Fig. 3). No irrigation is practiced and no fertilizer other than ashes is applied. Weeding is done only when the plants are young. A watch is kept against wild pigs, deer and monkeys until the crops are harvested. Temporary guard houses are built for this purpose in the fields. Harvesting begins by end of July and continues until November. Maize is harvested first; melons and vegetables follow; rice is reaped in September and October; and cotton is harvested in November.

Slash-burn agriculture practices on hill slopes exposes the soils to rapid erosion. Fertility of the soil is depleted with use and the fields cannot be used year after year. The farmer shifts from one plot to another every year or two. A half century ago a plot was reused every ten or twenty years. (Hutchinson, 1906, pp. 53-54). Today with increased population and government restrictions on areas of shifting agriculture, the same plot is used after three years of rest. The soils do not regain their fertility within this short time and yields are declining. Fields have no specific form but are generally irregular and are several acres large.
Agricultural Implements

In the remote past the sowing implement was a straight wooden stick with a pointed end. The digging stick has long since been replaced with a hill knife or dao (Fig. 3). It is a hatchet with a blade about sixteen inches long and three inches wide. One side of the blade is sharpened and the implement is set in a wooden handle. The dao is a multi-purpose instrument used to cut undergrowth and tree branches, dibble seeds and weed fields. It is also used to cut bamboo for house building, strip cane to fasten roofs, slaughter animals and kill poultry. Tribal people do not manufacture the dao but obtain it from their neighbors.

Houses and Storage

The tribes who practice shifting agriculture in the Chittagong Hill Tracts were formerly semi-sedentary. Today most of them live in permanent villages (Hutchinson, 1906, p. 53) and change their fields but not their dwelling places. During the growing season they live in guard houses erected in their fields and return to their villages after the harvest.

Mongoloid tribes of the Chittagong Hill Tract live in platform houses different from those of their neighbors (Fig. 4) but similar to the houses of Southeast Asia. Platform houses are built of bamboo and raised four to six feet from the ground with bamboo or wooden posts. The walls and floor are made of split bamboo flattened and then woven together. The roof is thatched with palm leaves called "krook pata," cane leaves or grass. Each married couple has one room. One room is set apart for the unmarried members of the family and another for cooking. In the front part of the house on the raised platform is an open space used for various
Hill Knife (Dao) is the chief agricultural implement of the Mongoloid tribal people in the Chittagong Hill Tracts.

Fig. 3

Platform house
Note the split bamboo walls and grass thatched roof
purposes: drying grain, grinding spices, and other household tasks. A storage room is erected in one corner of the open space. Usually grain and cotton are stored in bamboo baskets and yams and other root crops are piled on the floor.

**Plow Agriculture**

The invention of the plow revolutionized agricultural processes throughout the world. Production increased and the farmer's life became more sedentary. Draft animals and much later steam and gasoline engines were used to pull the plow. Field patterns changed from irregular to geometrical shapes and land tenure acquired more formal codes. Plow agriculture of Louisiana and East Pakistan are similar in basic ways but differ greatly in detail.

**Agricultural Implements**

The earliest evidence of plow usage comes from the Mesopotamian cylinder seals and Egyptian paintings of 3,000 B.C. (Cruwen, 1953, p. 12). The plow had reached the Indus valley by 2700 B.C. and not long after was introduced in East Pakistan (Chatterjee, 1951, pp. 154-160). The type used was the ard or Egyptian plow which probably evolved from the digging stick (Cruwen, 1953, p. 72). The ard is still used in East Pakistan but the plow now has an iron point (Fig. 5).

The ard has no moldboard and does not turn the soil but its small norn-shaped prong scores the soil to a depth of three to four inches. It is particularly unsuitable for sugar cane and tobacco fields which require deep plowing. This plow is inefficient, has no spade action, leaves unplowed ridges between the furrows, and does not eradicate weeds.
Fig. 5  Ard or Egyptian plow. This type of plow was developed about 3,000 B.C.
In 1936 the Government of Bengal recommended eight different types of plows more suitable for local conditions (Huda, 1949, p. 105), but they were not accepted by the farmers who are happy with their age-old ard. Cultural changes come slowly among people whose traditions are deeply rooted in the past.

Agricultural tools other than the plow are equally simple and primitive. A wooden ladder-like implement ("moi") drawn by bullocks levels the field and breaks the clods (Fig. 6). A man standing on the tool maneuvers it by applying his weight in specific places. A wooden rake ("nangila") with wooden or iron teeth is used for thinning and weeding the crops and breaking the soil crust (Fig. 7). For row crops the hoe is used to make ridges and furrows. In garden farming, where better preparation of land is required, the hoe replaces the plow. Grain crops are harvested with sickles and threshed by being trampled on the ground by cattle (Fig. 8). Rice and other grain crops are winnowed from the chaff by the simple method of plowing the grain slowly to the ground from a height of several feet. Wind blows away the straw and the grain falls on the floor. In winter when the wind is not strong enough to make this operation successful, the grain is spread on the floor and the straw is blown away with a hand fan.

In Louisiana Europeans introduced two types of plows, the moldboard and the Creole plow. Moldboards (Fig. 9) were used on river levees and hill areas but did not work well on the heavier soils near the backswamps. Creole plows which were mounted on wheels (Fig. 10) were used in heavy soil areas. The first known wheel plow was used in the 4th century
Fig. 6  A ladder-like implement ("moi") levels the field and breaks the clods.

Fig. 7  Rake ("Nangila") used for thinning and weeding.
Fig. 8 Threshing Rice. Note the central pole around which the cattle pivot. The net basket around the cattle's mouth is to prevent them from eating.
Fig. 9  An old type moldboard plow no longer in use. Iberia Parish

Fig. 10  Creole plow used on the heavier soils along Mississippi River south of New Orleans.
B. C. in Denmark (Cruwen, 1953, pp. 81-82). From there it spread to France and other sections of Europe and was brought to Louisiana by the French. Plows were drawn by oxen, mules, or horses but today tractors are widely used. The disk plow has essentially replaced the moldboard plow in Louisiana (Fig. 11).

The introduction of the tractor was an important invention in the mechanization of agriculture. A steam tractor was invented a few years before the Civil War (National Resource Committee, 1937, p. 98) but was large, heavy and difficult to handle. By 1900 gasoline powered tractors were available and were lighter and more easily used. Widespread adoption of the tractor awaited World War I and it was then that tractors in any appreciable number were used in Louisiana (Table 11). Early tractors were restricted to plowing and harvesting but were not satisfactory for cultivating row crops. An all-purpose tractor, introduced in 1924, was suitable for cultivation (Barger, 1942, pp. 202-205). In 1932 tractors were mounted on rubber tires and needed less repair; they were faster and made operations more comfortable and less fatiguing. The number of tractors in Louisiana continued to increase (Table 11) and during the farm labor shortage of World War II their use was accelerated. Although the number of tractors has increased more than ten times since 1920, the number of mules has decreased only by one-third. Many small farmers in hilly areas are still dependent upon animal power. Mechanization requires investment beyond the means of small farmers and animals are more satisfactory in the hill areas (Barlow, 1946. pp. 13-17).

Great improvements in seeding, harvesting and threshing implements
Fig. 11 Disk plow and tractor in the Prairie area.

Fig. 12 Grain Seeder. One bin is for seed, the other for fertilizer.
have been made during the last hundred years. The scythe and sickle have been replaced by the mower, reaper and binder. The combine which was introduced in 1880 superseded all other harvesting and threshing machines in the prairies (Rogin, 1931, p. 145). The corn-binder, corn-picker, sugar cane harvester, potato digger and other implements have revolutionized agriculture in Louisiana today. Virtually all crops can be planted mechanically and fertilizer is often spread simultaneously with the planting (Fig. 12). Rice, oats, alfalfa, soybeans and hay crops are planted by aeroplane on some large farms. Truck, automobiles and electricity are commonplace on Louisiana farms.

Field Pattern

With the introduction of the plow, field patterns became more geometrical (Cruwen, 1953, p. 61). Conforming to this pattern, the fields of East Pakistan and Louisiana are generally rectangular or square.

Fields are small in East Pakistan. In the village of Majhina Nadir Par (north of Dacca) the maximum size of plots is one acre and the minimum one-tenth of an acre (Ahmad and Khan, 1957, p. 43). In the villages of Kazikasba, Panam and Joraduel (south of Dacca), the size of some plots are only eight to ten square feet (Khan, 1957, p. 103). Average size of plots is about one-half acre in East Pakistan. Diked fields are purposely made small to impound water for irrigation since contour levees are not built. Secondly the division of property results in fragmentation of fields. If a particular farm has five types of land and is to be divided among four heirs, each heir will receive a plot from each type of land. Consequently the holdings are scattered and each scattered field becomes smaller
and smaller with division and subdivision.

Pakistani fields are generally aligned along rivers and roads (Fig. 13 and 14). Each plot is separated from surrounding plots by narrow ridges called "ails." The "ails" serve as boundary lines or as dikes for impounding rain water for rice culture. They also serve as footpaths for going from one plot to another without trampling the crops.

Fences are almost unknown. Sometimes fields facing roads are fenced with bamboo sticks or branches. Fragmentation of holdings make fencing impracticable and stall feeding of animals makes it unnecessary.

The size of Louisiana fields suits plow tillage, but their specific shape depends upon the system of land survey introduced by various ethnic groups. The French introduced the arpent system in which the fields are rectangles or trapezium (Fig. 15). Their distribution coincides with the early French settlements along the Mississippi, Red, Amite, Tangipahoa, Pearl and other Rivers (Fig. 18). The arpent is equivalent to 192 feet or nearly a linear acre. During the French regime each grantee received a tract of land fronting the river and extending to the backswamp. The side along the stream frontage was generally a few arpents, and measured forty arpents in depth. In case of multiple inheritance, each recipient received an equal share of the frontage and a full depth. In this way the elongated character of the plots was more accentuated. The arpent system had the advantage that each grantee had access to water transport and had a share in both good levee lands and inferior backswamp area.

The Florida Parishes were settled mainly by the British. They used an irregular mete and bound system of division. Consequently the fields do
Fig. 13  Field patterns along an abandoned railway line now used as road in the Barind area.

Fig. 14  Field patterns along a river in the Barind area.
Fig. 15 Arpent field pattern in Louisiana introduced by the French. Note the linear settlement, U.S.G.S. Donaldsonville Quadrangle, Scale 1:62,000
not have any uniform pattern (Fig. 16) but are square, rectangular or irregular in shape depending upon the amount of land cleared and the shape of the grant.

The major part of Louisiana has been surveyed in accordance with the General Land Office system. According to this system, all public lands are divided into townships six miles square and subdivided into sections one mile square. Roads follow the township and section lines and farms are located on the roads. Fields generally have a square shape (Fig. 17).

Fencing of fields was introduced in Louisiana by Europeans. The first fences in Europe date back to the 13th century A. D. when English lords fenced their fields (Gras, 1925, pp. 160-165) to keep their animals inside enclosures. Later all the lands were enclosed. The enclosure movement reached the main land of Europe in the 10th century and from there it came to Louisiana. In early days of Louisiana settlement fields were fenced to keep animals out; later the pastures also were fenced.

**Cropping Systems**

Intensive agriculture is practiced in East Pakistan as opposed to extensive in Louisiana. Multiple crops are regular practices in East Pakistan but are practically absent in Louisiana, except in truck farming areas. About one-third of the entire agricultural area of East Pakistan is cultivated more than once in a year (Government of East Bengal, 1954, Appendix III). The general practice is to plant rice or jute in summer and "rabi" crops like wheat, pulses and mustard in winter. It is not unusual to harvest two crops of rice from the same field in a year. In
Fig. 16 Irregular field pattern in Louisiana introduced by the British. Note the nucleated settlements. U.S.G.S., St. Francisville Quadrangle, Scale 1:62,000
Fig. 17  Square or rectangular fields in Louisiana as a result of General Land Office survey system. U. S. G. S. Crowley Quadrangle, Scale 1:62,000.
well watered areas even three crops are obtained. Sometimes one crop of jute or rice is followed by two crops of vegetables in winter (Khan, 1957, p. 104). A common practice is to sow cauliflower or cabbage in August after the jute harvest; the cabbage and cauliflower are mature in November and December and radishes or mustard follow. After they are harvested in February or March the land is prepared for another crop of jute. Double and triple cropping are rarely practiced in the Pleistocene terraces and the Tertiary hills, because of the low fertility and lack of rainfall in winter. Multiple cropping is less important in the "bil" areas which are not cultivated in summer because of excessive water. Areas newly reclaimed from the Sundarbans in the Khulna district are also mono-cultural because of saline conditions.

Interculture, or growing more than one crop at a time in a field simultaneously, is also practiced in East Pakistan. Louisiana farmers adopt this practice occasionally in truck areas. In East Pakistan, however, interculture is practiced with crops other than vegetables. It is a common practice to plant tobacco in the center of and surrounding a potato field, particularly if the field is located on a path. Tobacco is a licensed commodity and excise duty is levied on it. In order to avoid the tax and to produce sufficient quantities for domestic use it is grown in a dispersed manner. Tobacco grown around a potato field also protects the potato from animals, particularly goats, which do not eat tobacco. Mustard and gram (Cicer arietinum), turnips and radishes, potatoes and chillies, tomatoes and brinjals are some of the crops which are grown together. In many house gardens, beans, gourds or pumpkin vines grow up on a thatched roof and the
ground is planted with tomatoes, brinjals, okra and other vegetables.

Crop rotation in East Pakistan is practiced to a limited extent. Jute and rice are planted in alternate years in some areas and this is the most common form of rotation. As a rule the same winter crops is not grown two consecutive years. Farmers are aware that the same crop deteriorates soils, but do not follow any set rotation practice.

Crop rotation in Louisiana is practiced on an extensive scale. Most farms specialize in one cash crop such as sugar cane, rice, cotton and others. A common practice is to rotate the crop with pasture. Legumes like lespedeza, alfalfa and clover are usually grown which make good feed and also enrich the soil. Normally cash crops and hay crops are rotated during alternate years. In the prairie area two years of rice followed by three years of pasture has proven most satisfactory (Mullin, 1954, pp. 26-27). Grasses grown as a rotation crop are quite unknown in East Pakistan. Leguminous pulses help replenish the soil but are not grown primarily as green manures.

Irrigation

The time and place of the origin of irrigation are not known but in the beginning it was probably of a supplemental character (Steward, 1956, p. 72). By 3,000 B. C. it was practiced in China, Mesopotamia, the Indus Valley and possibly other areas. Although the exact date of its introduction in East Pakistan is not known, it has been used since prehistoric times.

Irrigation is not extensively utilized in East Pakistan. Only two and one half per cent of the total cultivated land is irrigated. If
irrigation is extended double crop acreage will be increased considerably. The Ganges-Kobadak, the Tista Barrage, the Tangon Irrigation, and the Ganges Flushing Projects are expected to add substantially to crop production (Fig. 19). The Ganges-Kobadak and Tista Barrage Projects will bring 95,000 and 510,000 acres of new land under cultivation respectively (Pakistan Publication, 1956, p. 145). With the exception of Sylhet and Chittagong Districts, all districts noted for irrigation are located on the western part of East Pakistan, where rainfall is less and winter crops are important. The most important irrigated crop is rice which accounts for more than fifty per cent of the irrigated acreage (Government of East Bengal, 1954, Appendix IV). Sugar cane, pulses and vegetables are other important irrigated crops.

In East Pakistan five methods of irrigation are practiced: "klash" (pitcher), "don," "seunti" (Swing Basket), "Kopikal" or "Dhekikal," and canal. In "klash" irrigation which is the most common, a vessel is filled with water from ditches, ponds and "khals" and poured on the fields. It is employed when the area to be irrigated is small or the field is not to be overflooded or when individual plants need water. Some higher lands are irrigated laboriously by the "klash" method.

"Don" is a device for lifting water in a boat-like wooden trough from a "bil," canal or tank; the water is then directed onto the field through the ditches (Fig. 20). "Boro" rice in the eastern part and "aman" rice in the western part of the province are irrigated by this system. The "Seunti" or swing basket is used to lift water in a bamboo basket or kerosene container from a ditch into the field (Fig. 21). The bucket is
EAST PAKISTAN
MAJOR IRRIGATION PROJECTS

Fig. 19
Fig. 20  Irrigation by "Don." Note the wooden trough held by the man. Irrigated field is in the forefront.

Fig. 21  "Seunti" or swing basket used for lifting irrigation water from a ditch. Note the water being poured from a kerosene container into a trough.
De salir abandonados:

De la, la, la, la,

De la, la, la,

De la, la, la,

Verguen chil nan.

(De la, la, la, ya tiene dicho: la, la, la, la,

De maridad, con ironía, al que la cortaiga:

Ruego en esta hera escena trágica

como le pidejo

la él viajera.

(De las ocho que va con miendo el retrato:

immanes caído incierto

guiado y la juntura trágica

algunas momentos de tres aprenden controla trágica.

[La bata de la varita de inciarse encima con

la muerte, ya que por el instinto hierro y la aparición trágico,

la emergencia trágico esconaleda].

De los ocho ocho:

Busco heridas perdiendo irais

perdiendo dañado

Egiptaita no que

Alrededor del aceite.

[Las ocho ocho estarán contenidas, porque

se ha hecho durante el uso del otro].

Los espumas hierve lo quieren solo para el niño:

Arre, arre, amado;

Arre, herido;

Arre, arrastrado;

Arre, apretado;

Arre, apartado;

Arre, arrancado;

Arre, apretado;

Arre, amarrado;

Arre, apretado;

([Mancha, mancha] lamentado. Mi abuelo, ni era, mi

abuela, ni era. —Dime yo, llena; mi abuela, ni era, ni era. —Dime yo, llena; mi

abuela, ni era].

El viaje al mar: 

Arre, arre, mi abuelo está a lomos;

De ella que se quedó, ya le a un chido.

Pero, eso, buen chute; mi nuestro niño, al este boca.

[Seguía el viaje en carros... Hasta los periquitos:

Polichinela del mal

Santillanes;

santo ermita ben

Incongruentia.]

[Los periquitos vienen de Santiago; el viaje por vería].

El viaje al mar; en el viaje del mar:

Rico de sobre, capaz estar;

Santo ermita ben

[Esto le sube, bien venido, buenos moches

con el ptajero].

El aliento con su pregunta:

[En el viaje se da

De las ocho

[Para el blum que]

De las ocho

[Para el blum que]

De las ocho

[Para el blum que]

El viaje por el mar: 

[Hay tres pollos y perros contra el clímax de

se contó lo antes de mis pollitos: la aura lo

se contó el niño, y el vellor susto el bismo].

El viaje por el mar:

[—Arre, arre]
Fig. 22 "Dheki Kal" or "Kopi Kal" used to lift water from wells or deep rivers and "khals"
In the hill areas of Louisiana irrigation has been possible only in recent years since the development of water sprinklers and heavy leveling machines.

There are three main sources of water in Louisiana for irrigation purposes; streams, wells and ponds in order of importance (Weigmann, 1956, p. 13). Streams are more important in the Mississippi and Red River valleys; in the prairie rice area wells supply more acreage than other sources, but streams are also important. Ponds are significant only in parts of the Tertiary hill area where irrigation is not very extensive.

Three methods of irrigation are practiced in Louisiana; sprinkler, flooding and furrow. The method adopted depends primarily upon the crop and secondarily upon the topography. The sprinkler system is not used for row crops nor in heavy soil where water is more likely to run off (Severance and Koch, 1955, p. 11). Its advantage lies in the fact that it can be used both on flat and rough lands and the amount of water can be controlled. Sprinkler irrigation is most common in the Tertiary hills and in the northern part of the Florida Parishes. It is least important in the flat prairie region and in the Mississippi delta.

Flood irrigation is the application of a sheet of water over land inside dykes. It can be applied only on level land, preferably with a cross slope of one inch per 100 feet and lengthwise slope of six inches (Severance and Koch, 1955, p. 8). Originally this was obtained by building dykes around square and rectangular fields but today contour levees are used (Fig. 23). In the early days of irrigation, water was brought to the fields in canals from the river through breaches in the levees; today siphon
Fig. 23 Irrigation of rice field by siphon tube. Note the contour levee. Common along the Mississippi River.

Fig. 24 Canal irrigation. Water is pumped from a well inside the wooden structure in the Prairie area.
tubes are generally used (Fig. 23). In the prairie region water is obtained from wells and is then conveyed through canals to the fields (Fig. 24). Furrow irrigation is used for row crops where water is applied to each row. Gated pipes or open ditches with siphon tubes are commonly used to carry water to the furrows.

Manures and Fertilizers

Manuring practices in East Pakistan are centuries old. They are primitive and the quantities used are insufficient. Cow dung is the chief manure. A substantial quantity of it is used as fuel (Fig. 25), thereby reducing the amount available as fertilizer. This is especially true in areas where jute cultivation is not extensive, for where jute is grown, its reeds form an important source of fuel. Cow dung is stored in open pits and is spread on the fields a few days before they are cultivated. It is used for all crops, particularly jute. Cow urine is not used except for banana cultivation. Mustard oil cake is next in importance as a fertilizer. Its heaviest use is for potatoes, though it is also used to fertilize betel vine, bananas and sugar cane crops. Ash, bone dust, and fish meal are used in limited quantities. Water hyacinths are abundant in East Pakistan and are rich in potash; they are specifically useful on jute, tobacco and sugar cane fields. The application of water hyacinths as fertilizer has not been commonly adopted despite the efforts of the Agriculture Department to utilize it.

An age-old fertilizing technique is employed in some areas of East Pakistan. Sediments that accumulate in the 'khal,' ditch and tank bottoms is removed before the rainy season and spread on the fields. It
Fig. 25  Cow dung pressed around jute stems being baked in the sun to be used as fuel.
is used only for betel and banana gardens which are located above flood level and brings a cash return.

A few years before the creation of Pakistan, the use of ammonium sulphate as a fertilizer was introduced in the province. To encourage its use the government has been selling it at subsidy rates since 1951. Its usage has increased considerably; primarily for cash crops such as sugar cane, tobacco, tea, bananas and vegetables.

After the arrival of the Europeans in Louisiana, compost was the principal fertilizer. When the Agricultural Experiment Station was established in 1885, artificial fertilizers were developed and bulletins were issued recommending methods for its use. Chemical fertilizers were used in substantial quantities in the later half of the 19th century (Stubbs, 1894, pp. 1101-1102). In cotton country, a compost of stable manure, cotton seed and acid-alkaline was in general use. Among the green manures, cow pea was used by sugar cane planters and peanut farmers of north Louisiana.

Today the Agricultural Station makes recommendations for different crops and soils, times when fertilizer should be applied, and the amounts necessary (Sturgis, 1957, pp. 1-8). Most farmers follow the instructions and the amount of fertilizer used has increased greatly. Chemical fertilizers cost the Louisiana farmers $1.8 million in 1920 and $18.9 million by 1954 (U. S. Census of Agriculture, 1954, State Table 7).

**Farm Houses and Buildings**

Farm houses, storage facilities and animal sheds of East Pakistan are quite different from those of Louisiana. In the matter of settlement
Fig. 26  Linear Settlement in Deltaic Plain of East Pakistan Aerial Photograph, Scale, 1:20,000
Fig. 27 Dispersed Settlement in Tippera Surface, Aerial Photograph, Scale 1:20,000
Fig. 28  Nucleated Settlement in Barind, Aerial Photograph, Scale 1:20,000
patterns, however, some parallellisms are apparent. Linear settlements along river levees, roads and railways have developed in both areas (Figs. 15 and 26). In Pakistan dispersed settlements of isolated homesteads are common in the "bils" and in the Tippera area (Fig. 27). Dispersed settlements are found in the prairie region in Louisiana. Nucleated villages around the tanks in the Barind region and the Madhupur Jungle (Fig. 28) can be compared with English settlements in the Florida Parishes and the hill area of Louisiana.

East Pakistan farm houses called "baris" consist of several separate rooms opening in a common courtyard and surrounded by a cluster of trees (Fig. 29). Normally a "bari" has four rooms forming a rectangle. Close to the four rooms a separate kitchen is constructed. Sometimes the kitchen is combined with one of the living rooms. Generally a fifth room for guests is built a small distance away from other rooms. Some rich or large families have eight rooms in their "baris." A poor farmer may have only one room, but he too will have a courtyard.

Of the four rooms, two opposite rooms usually have saddle-roofs called "bangla" or "do-Chala" and the other two rooms have separate pyramidal roofs called "chau-chala" or "chauri." Some of the pyramidal roofed structures have more than one room; they are then called "ath-chala." Rooms with pyramidal roofs are used for living purposes or for guests. Rooms with saddle-roofs may be kitchens, store rooms or living rooms. The plaza or courtyard serves several purposes; it is used for threshing, drying grains, cooking on hot rainless days, dancing and singing, marriage ceremonies, as a chicken yard and other
Fig. 29  East Pakistan Farm House (A) Do-chala, room with saddle-roof (B) Chau-chala room with pyramidal roof (C) Atn-chala pyramidal roofed structure with two or more rooms (D) Guest room (E) Plaza
uses. Every farmer who can afford one, has a tank (artificial pond) adjacent to his "bari" (Fig. 30). The tank is multipurpose; it supplies drinking water for both man and beast, contains fish, serves as a bathing pool, and is used for washing clothes and utensils.

Pakistani farm houses are built of clay and bamboo with roofs of reeds and leaves. Golpatta (*Nipa fruticans*) in the south and "ulu" grass in the north are common roof thatching materials. A house with a roof of corrugated metal sheets is sign of prosperity and if the walls are also of metal greater prosperity is signified. House walls made only of clay are found in the Pleistocene terrace area where they are safe from floods and where the red earth has sufficient adhesiveness for wall construction.

East Pakistan house patterns appear to be of local origin. The distribution of this house type extends into West Bengal and into parts of Assam where it was carried by the people of Bengal. It is quite unknown in the adjacent provinces of India.

The zamindars built double story brick houses within large enclosures. One or two large tanks with cemented stairs leading into them are inseparable parts of the lay out. They also have gardens planted with flowers, fruit and decorative trees. Areca nut, coconut, mango, jack fruit and banana are the common fruit trees. Pine is the common tree used for decoration, but sometimes eucalyptus trees are also planted. The zamindar's house stands out in striking contrast to single-story tenant houses which are made with mud and bamboo walls and thatched roofs. The zamindars also maintain outhouses for the collection of rents, servant quarters and cow-sheds. Sometimes they build a separate brick building, called a "kachery",
Fig. 30 East Pakistan Farm House (A) Cows shed behind a living room (B) Tank.
Fig. 31 An earthen jar, four to five feet high for storing grain. Note the hole near the bottom for taking out the grain and the circular disk which seals the mouth after the grain is stored.
at a small distance from the settlement for the collection of rent. The post office, school, inspection bungalows, market, if any, are also located close to the "kachery." The whole setup imparts a distinct color to the rural landscape. Since the zamindary system has been abolished the abandoned buildings are being used for museums, schools, and living quarters for revenue officers. "Kacheries" are still used for the collection of revenue but under government supervision. In East Pakistan there is no barn like those of Louisiana. Saddle-roofed cow sheds are usually located at a small distance from the living rooms or attached to the back of the house (Fig. 30). Poor farmers who have no shelter for animals share their living rooms with them.

Storage facilities in East Pakistan are rudimentary. Normally there is no separate structure for storage but farm products are kept in the living rooms. Grain is stored in bamboo baskets on platforms built along the living room walls and jute is kept in the attic. In Rajshahi District grain is kept in earthen jars (Fig. 31). The mouth of the jar is sealed with a clay disk after the grain is stored; a hole near the bottom of the jar allows grain to be removed as it is needed. The jar is air tight when the mouth is sealed and the grain is safe from insects and pests. This system was introduced into East Pakistan from northern India.

Louisiana farm houses represent the ethnic groups which have settled in the state (Kniffen, 1936, pp. 179-180). Along streams in French areas, Creole and shotgun houses are most common. Creole houses have gables facing sideways and front porches are integral parts of the roof structure; the chimney is in the center of the house (Fig. 32). Shotgun houses are
Fig. 32 Creole house. Note the chimney in the center. Plaquemine Parish.

Fig. 33 Shot-gun house. Note the frontwood facing gables. Pointe Coupee Parish.
long, narrow structures with gables facing the front (Fig. 33). They are one room in width and may be two or more rooms in depth. A modified shotgun house called a bungalow has two rooms wide and at least two rooms deep.

Double pen houses (Fig. 34) were introduced by the Scotch-Irish in Louisiana (Wright, 1958, p. 109). They are usually found in the piny woods of the hill area of Louisiana and the Florida Parishes. They have sideward facing gables with steep roofs projecting on either end and extending out to form porches. The chimney is located on the side. The distinctive trait of the double pen houses is the presence of an open passage way running from front to rear.

Farmers from the mid-west introduced two storied mid-west type houses (Fig. 35). They frequently have sideward facing gables and are one room deep. Sometimes they are square double story houses with a pyramidal roof. Mid-west houses are most common in the heart of the prairie area. Palatial double story plantation houses are a remnant of Louisiana's Ante-Bellum period (Fig. 36). In recent years ramblers and their modifications have gained popularity.

Most houses in Louisiana are built of wood and constructed on concrete piers. Houses built on slabs are recently becoming common. An inner court yard like those of East Pakistan is unknown. The house faces the road or streams with out houses built slightly behind.

Several types of barns are noted. A single-shed barn is one in which a saddle-roof structure is divided length-wise into small rooms and a large central room (Fig. 37). Sometimes a single shed is attached to
Fig. 34  Double pen house. Note the chimneys on the ends. East Baton Rouge Parish.

Fig. 35  Double story Mid-west type house. East Baton Rouge Parish.
Fig. 36  The Cottage Plantation house, East Baton Rouge Parish.

Fig. 37  Single-shed barn. Note the large central room, Franklin Parish.
Fig. 38  Double-shed barn.  
Vermillion Parish

Fig. 39  Double roof barn.  West  
Baton Rouge Parish.
Fig. 40  Single roof barn without gables, Cameron Parish

Fig. 41  Hip-roof barn, Tensas Basin.
YIELD OF RICE PER ACRE IN EAST PAKISTAN AND LOUISIANA

Source of Data: Season and Crop Report of East Bengal, 1901-1941; Government of East Bengal; Agricultural and Animal Resources of East Bengal, 1955
Montgomery, Agricultural Statistics for Louisiana, 1909-1953
Fig. 42
one side of the barn with the roof either joined or set lower against the wall. If a shed is attached to both sides it is called a double-shed barn (Fig. 38). When the attached sheds are lower than the main shed, it is called a double-roof barn (Fig. 39). In coastal Louisiana single roof barns without gables are found (Fig. 40). Hip-roof barns are widely distributed throughout the state (Fig. 41). The principal room of the barn is generally used for vehicles, carts, wagons and tractors and there is usually a loft for forage. The sheds on the sides are used either for animal stalls or tool storage.

Storage facilities for each crop are no longer a common feature of Louisiana farms. Storage of cash crop is handled by commercial warehouses, public elevators, mills and factories. Rice is threshed by combine, loaded in trucks and taken to the dryers. Cotton goes to the cotton gin and sugar cane to sugar mills. Vegetables are canned or rushed to cold storage and super markets.

**Summary**

Agricultural practices of East Pakistan and Louisiana are quite different. In East Pakistan farming is carried on by primitive methods. Soil is plowed with a wooden ard; weeding, thinning and harvesting are done by hand with simple hand tools. Manures and fertilizers are used in small quantities, and chemical fertilizers have only recently been introduced. Disease and pest control are insignificant and storage facilities are rudimentary. In contrast, agriculture in Louisiana is mechanized. Fertilizers are used extensively, insecticides are in general use and proper storage facilities are available. Differences in the agricultural practices of the two areas are reflected in the yield of crops (Fig. 42).
CROPS

Before 1500 A.D., different crops were grown in East Pakistan than those in Louisiana. In East Pakistan, rice, pulses, oilseeds, sugar cane, jute and others were produced. All these crops belong to the Old World. In Louisiana corn, beans, squash and tobacco were grown; these were New World crops. With the advent of the New World Revolution, crops were introduced from one hemisphere to another. The introduction was selective, depending upon certain culture values. A new crop was abandoned if it did not thrive in the new environment or if it was not culturally accepted. In the early days of colonization several attempts were made to grow wheat in Louisiana because it suited the dietary needs of the emigrants. But wheat did not thrive in the wet climate of Louisiana. In East Pakistan wheat was introduced in ancient times, but it did not gain importance because it was not culturally accepted, and because it does not produce as much food per acre as rice. Indigo and tobacco were important crops in Louisiana during the 18th Century. By the end of the century, world markets found better sources of indigo and tobacco and these products disappeared from the agricultural scene of Louisiana. Indigo became an important crop of East Pakistan late in the 18th Century but completely disappeared after 1897, when synthetic indigo was produced.

Rice has been grown in East Pakistan since ancient time and is still the basic food. In Louisiana, it was introduced early in the 18th century and is still an important crop. Similarly, tea and jute in East Pakistan
and sugar cane and cotton in Louisiana have maintained their important positions. The distribution within the two areas, however, changed with changing technology and a better knowledge of the plant's physical requirements. A study of some of the important crops will show how the crop complex has changed in the past and is changing today.

**Indigo**

The leaves of the indigo plant (Indigofera) are used for the manufacture of dye. The plant was known in India in ancient times. Several early explorers and writers, Pliny, Periplus and Marco Polo, mentioned its presence in India (Majumdar, 1938, p. 209). Vavilov thinks it is native to India or was introduced at an early date from China (Vavilov, 1950, p. 28). When the Europeans came to India, indigo was grown in the southern and western sections of the country but not in Bengal (Hunter, 1908, pp. 69-70). Soon after the discovery of the Cape of Good Hope route in 1498, the Portuguese introduced the indigo dye in Europe. Its use spread through France, Germany, Holland, England and other countries. In the later half of the 17th Century, its trade flourished and European colonists in America began to grow indigo and manufacture dye. It was widely planted in the West Indies and Guatemala where it was introduced by the Spaniards. From there, the plant was introduced into Louisiana by the French during the early days of colonization (Post, 1933, p. 573).

It was in the later half of the 18th Century that the East India Company introduced indigo cultivation into East Pakistan (Hunter, 1908, p. 71). The chief cultivated species was *Indigofera sumatrana*. In the
closing years of the century Natal Indigo (*Indigofera arrecta*) and Guatemala Indigo (*Indigofera Oligosomera*) were introduced. The Natal and Guatemala plants gave higher yield than other varities.

Indigo seeds moderate temperature and sufficient moisture at sowing time, and high temperatures and heavy rainfall at the time of vegetative growth. It grows best in tropical and subtropical areas that have sufficient summer rainfall. Indigo can be grown in varied soils but deep alluvial loam suits the crop best. On an average it consumes about forty pounds of nitrogen per acre, so it does not grow well in soils deficient in humus (Ibid., p. 71).

Early planters in Bengal were Europeans and the cultivators were native. By the middle of the 19th century, trouble arose between the two groups, and a large part of the indigo industry migrated to the adjoining provinces of India (Ibid., p. 70). In 1897 Germany produced a synthetic indigo (Kreps, 1931, p. 302) and the indigo industry of East Pakistan was seriously affected and completely disappeared by the 1920's. Today the ruins of indigo factories (hilkuthi") and the prefix "nil" (indigo) before some village names are relics of the past.

In Louisiana extensive cultivation of indigo started after 1722, when a shipload of indigo seeds from CapeFrancaise arrived (Gray, 1941, p. 73). By 1725 the product was exported. Indigo was planted first in the vicinity of New Orleans, then spread northward along the Mississippi River and subsequently along the Teche River. The industry continued to grow until the last decade of the 18th century; serious competition from other countries made it unprofitable to grow and ravages of insects
destroyed the plants. Abandoned indigo plantations were planted mainly with sugar cane.

Tobacco

Tobacco belongs to the genus *Nicotiana* which has many species. Only two of the species, however, are cultivated, *Nicotiana tabacum* and *Nicotiana rustica*. The former is used for the manufacture of cigarettes, cigars and "biri" (small cigar of East Pakistan), and the latter for snuff and chewing. Both are used for medicinal purposes and in Pakistan for the smoking of the "hukka."

America is the origin of both species of cultivated tobacco. According to Vavilov, *Nicotiana tabacum* originated in the area of Ecuador and Bolivia, and *Nicotiana rustica* in Southern Mexico and Central America (Vavilov, 1950, pp. 39-41). When the Europeans came tobacco was cultivated widely in North and South America.

The tobacco plant was introduced into India by the Portuguese in 1605 (Hunter, 1909, p. 49). It is not known when tobacco cultivation extended from India into East Pakistan but it was grown in East Pakistan by 1790 when an organized effort was made by the government to start tobacco cultivation on a large scale (Vas, 1911, p. 62). Seeds were brought from Virginia and cultivation was started in Rangpur District. Since then tobacco cultivation has been continuous in the province.

Tobacco requires a warm and fairly humid climate. Optimum conditions for tobacco appear to lie between 64° and 80° F. (Garner, 1941, p. 367). It requires a regular supply of moisture during the period of growth but does not need heavy rainfall and cannot tolerate water-
logging. Tobacco is a winter crop in East Pakistan because of heavy monsoonal rainfall and overflooded conditions in summer. In Louisiana it is a summer crop.

In East Pakistan the seed is sown in nurseries in August and September and transplanted into fields from October to the middle of December. The land is plowed ten to twelve times and well manured with cow dung and house sweepings before transplanting the seedlings. Planting is done on a checkerboard pattern with a distance of two to three feet between plants. Weeding and irrigating are needed until just before harvesting which is done in February and March.

Both Nicotiana tabacum and rustica are grown in East Pakistan. The Piedmont Alluvial Plain, particularly the Rangpur District is the chief area of tobacco production. It was there that the first large scale cultivation of tobacco began. Another area of tobacco production is in the Dacca and Mymensingh Districts. Tobacco is cured largely in homes, and only recently has a tobacco factory been established at Chittagong.

In Louisiana the French were interested in tobacco production because they imported large quantities of it from the British colonies. In 1719 an organized attempt was made by M. de Montplaisir to grow tobacco near Natchez (Gray, 1941, pp. 69-72). The tobacco industry slowly spread into other areas during the French regime. Natchez, Mississippi and Pointe Coupee were the chief centers. In 1763 Louisiana was transferred to Spain and from that time on the industry began to decline and almost disappeared by 1812. At the present time about 1000 acres in St. James Parish is planted in Perique tobacco (Harrison, 1947, p.2). It is grown by the
Acadian French who were taught how to raise it by the Indians. Perique tobacco is primarily blending tobacco.

Rice

Rice is the staple food of East Pakistan and also an important food in Louisiana. It is prepared in several ways in both areas. In East Pakistan it is popped and rice beer is a common drink among the tribal inhabitants of the Chittagong Hill Tracts.

Rice belongs to the genus Oryza, of which there are twenty-three species (Chatterjee, 1948, p. 185). Twenty-one of the species are wild and two are cultivated: Oryza glaberrima and Oryza sativa. The former is found only in west tropical Africa, while the latter is found wherever rice is grown. Africa has the largest number of wild varieties and south and southeast Asia (particularly, India and Indo-China) are richest in diversity of forms (Ibid., 1951, p. 18). On this basis Vavilov concludes that India was the birthplace of rice (Vavilov, 1950, p. 29). Roschevicz believes that cultivated rice began first in south and southeast Asia, mainly India and Indo-China, where conditions for mass mutation are favorable (Roschevicz, 1931, p. 1). Watt and de Candolle also consider India to be the home of Oryza sativa. Linguistic evidence also points to the oriental origin of rice. The Tamil word (a language of South India) for rice is Arishi. Arabs adapted this word and called rice Arruzz or Uruzz (Chatterjee, 1951, p. 21). Greeks modified the Arabic Uruzz to Oruza from which the botanical name Oryza was derived. The different European names riza or rizo (Italian), reis (German), riz (French), and rice (English) are modifications of Oruza. According to Mehdihasan, the generic name Oryza
was derived from the Chinese word Ou-li-lz, meaning good grain of food. (Idem). He further asserts that the Tamil word Arishi also is derived from the Chinese word, Li-Zz.

Old Hindu scriptures bear ample testimony to the antiquity of rice in India. Rice is mentioned in Atharved about 1000 B. C. (Chatterjee, 1951, p. 20). In South India rice was the chief offering to God and was found in many varieties before the Aryans came into India. In China rice was used around 2800 B. C. in a royal ceremony.

There are many varieties of rice and each variety differs in its temperature, moisture and soil requirements. Generally speaking, rice requires fairly high temperatures and an abundance of water and grows in a wide range of soils. A temperature of 68° F, or more for two or three months is needed for blooming and ripening (Wickizer, 1941, p. 18). Rice plants are intolerant of frost and a minimum temperature of 50° F. is required for germination. In Louisiana rice is a summer crop, whereas in East Pakistan it is grown throughout the year.

Rice does not thrive in areas where the rainfall is less than 40 inches except where irrigation is practiced. Lowland rice fields are kept flooded with five to six inches of water during the growing season. Upland rice grows without flooding, but requires frequent showers. Rice is thus ideally suited to monsoonal areas like East Pakistan where summers are hot and rainy seasons are long and coincide with summer. Briggs and Shantz have shown that water requirement of rice are similar to those of rye (Sen, 1937, p.104). An experiment done by Sen shows that two to three weeks' flooding of Aus rice (autumn harvested) and seven weeks for Aman rice (winter harvested)
helps tillering processes. Thereafter, wet conditions but not standing water are more beneficial (Sen, 1937, pp. 105-106).

Flooding of rice fields requires level land. River valleys and deltas and coastal plains are suitable areas, otherwise terracing is required. East Pakistan and Louisiana are comparable in this respect. With the exception of sandy soils which are permeable, rice can be grown successfully on soils ranging from silt loam to clays. An impermeable subsoil like that of the prairie soil of southwest Louisiana is preferable. Lateritic soils are unsuitable for rice culture, but the red soils of East Pakistan are used because of the high density of population. Rice crops exhaust the organic matter and nitrogen supply of soils. In East Pakistan rice receives little manuring; a little cow dung is used if there is any left after it is applied to other crops. In alluvial soils, rotation with jute and annual inundation keeps up the fertility. In Louisiana commercial fertilizers are used extensively and rotation with pasture is practiced (Sturgis, 1957, pp. 660-665).

In East Pakistan most of the "Aman" and all "boro" rice is transplanted after the fields are plowed and dyked to hold the rain or irrigation water. All weeds are cleared by hand. In Louisiana a considerable acreage is sown with grain-fertilizer drills, or sown by aeroplane (Fig. 43). Fields are thoroughly plowed and contour levees are built to impound the water. In the alluvial sections dykes similar to those of East Pakistan were formerly used (Stubbs, 1900, p. 385). In East Pakistan "aman" rice is irrigated only in the Barind area; "boro" rice is always irrigated. In alluvial areas of Louisiana, rice is irrigated by water drawn from rivers
Fig. 43 Rice Sowing by aeroplane. Normally sowing is done in a flooded field. Note the man with the flag. Another man is standing at the other end of the field. The aeroplane flies along the line formed by the two flag-men. After every pass by the plane the flag men move about 30 feet. Ascension Parish.
with syphon tubes. Water from artificial wells reaches the fields by canals in the prairie area. In East Pakistan sowing, weeding and harvesting are done by hand. In Louisiana manual labor was used extensively until the 19th century on small farms (Ibid., p. 386); today sowing is done by drills, aeroplanes, and harvesting and threshing by combines.

Rice occupies eighty-two per cent of the total farmed area of East Pakistan. It is grown on Tertiary hills, Pleistocene terraces and Recent flood plains, on river levees and "bils," also on poor laterites and rich alluvial soils. Rice occupies land reclaimed recently from the Sundarbans, where no other crop thrives because of saline conditions. The production of rice is not restricted to any season. It grows all the year round in one part of the province or another. This wide distribution of rice is possible because new varieties requiring different conditions have been developed. Upland rice is grown on the hills, where flooding is not possible. Lowland rice occupies the terraces and flood plains. There are three main varieties of Lowland rice, "boro", "aus", and "aman". "Boro", the post-flood rice, is grown in winter and occupies the Lowlands (Plate XI A); "aus" mainly depends upon nor'wester rainfall and cannot stand deep standing water (Plate XI B); it is sown in March-April and harvested before lands are flooded completely. It is also grown on river levees and other high lands which escape floods. "Aman" is the main rice crop. It is produced extensively in lands of varying conditions (Plate XI C). Some "aman" rice grows in areas where five to fifteen feet of water accumulates (Allen, 1906, p. 92). The plant attains a height of 20 feet. The growth of "aman" rice keeps pace with the rising flood; at times it grows twelve
PLATE XI

EAST PAKISTAN
BORO RICE
1950-54
ONE DOT REPRESENTS 2,500 ACRES

SOURCE OF DATA: GOVT. OF EAST BENGAI
AGRICULTURE AND ANIMAL
RESOURCES OF EAST BENGAI, 1955.

EAST PAKISTAN
AMAN RICE
1950-54
ONE DOT REPRESENTS 5,000 ACRES
EAST PAKISTAN
AMAN RICE
1950-54
ONE DOT REPRESENTS 5,000 ACRES

SOURCE OF DATA: GOVT. OF EAST BENGAL,
AGRICULTURE AND ANIMAL
RESOURCES OF EAST BENGAL, 1955.
LOUISIANA RICE 1950
ONE DOT REPRESENTS 2,500 ACRES

SOURCE OF DATA:
U.S. CENSUS OF AGRICULTURE, 1950

MILES
0  20  40
inches in twenty-four hours. Rice was grown as a subsistence crop during the early settlement days of Louisiana and did not become an important crop in the state until after the Civil War (Stubbs, 1900, p. 377). In 1885 Duson Brothers produced a successful crop of irrigated rice near Crowley. This opened the prospects of rice-growing in the prairies. Rice was first grown in shallow basins which were flooded by rain water. An impervious subsoil did not allow the water to seep through. This rice was called "Providence rice" because it depended largely upon nature. By 1889 rice acreage was extended so much that Louisiana became the leading state in the nation in rice production. Large numbers of grain farmers moved into the region from the Midwest and brought the latest machinery for the cultivation of grain. Irrigation from rivers and wells and suitable soil made the prairies the main rice area of Louisiana (Plate XID). In the 1880's Honduras rice was introduced in Louisiana (Ibid., p. 208) and shortly afterward Japanese varieties entered the agricultural scene. In 1912 Blue Rose (Japanese) was introduced and was the leading variety until 1945 (Jodon, 1955, p. 3) when Zenith replaced it. Zenith, an earlier maturing variety, is more suitable for combining and drying and is still one of the leading varieties. Rexora, a late maturing variety, was released by the Agricultural Experiment Station in 1928; Bluebonnet, a midseason variety, was released in 1948, and Magnolia, an early variety, are other popular types.

**Pulses**

Edible seeds of some leguminous plants are called pulses. Gram (*Cicer arietinum*), masur (*Lens esculents*), mash (*Phaseolus mung*), mung
(Phaseolus s. sureus) and khesari (Lathyrus s. satirus) are important pulses raised in East Pakistan. They are an important source of protein and all except khesari are made into curry and used with boiled rice like gravy. Khesari is used mainly as fodder. Kushtia, Dinajpur and Faridpur Districts produce most of the pulses. Khesari is grown primarily in the eastern part of the province. Most of the leguminous pulses either originated in the Indus Valley or in the adjoining parts of Afghanistan and Persia (Sauer, 1952, p. 79). They were introduced in East Pakistan by the Dravidians and Aryans.

Oilseeds

East Pakistan produces a number of oilseeds of which mustard (Brassica) and (Sesamum indicum) are important. They are raised during the winter season along the Meghna and old Brahmaputra River and in the Piedmont Alluvial Plain. The oil extracted from the oilseeds is used for cooking and forms an important source of fat; and the cake is used as fertilizer and animal feed.

Corn

Corn (Zea mays) is an American contribution to world agriculture. When Europeans came to America, they found it growing extensively both in North and South America and it formed the basic food in large areas. It was also used in religious and ceremonial occasions and for medicinal purposes. In America today it is an important food for both humans and animals. It is also used for the manufacture of starch, glucose, alcohol, paper, plaster boards and numerous other products. Corn is produced in East Pakistan, but is secondary as human food. Primarily it is eaten by
the less fortunate groups and by tribal people. It is prepared in a number of ways, roasted green, popped, and made into sweet ball. Hindus and tribal inhabitants use it in religious ceremonies.

That America is the original home of corn (maize) if accepted both by anthropologists and botanists (Weatherwax, 1954, p. 138). Widespread distribution of the plant in the Americas, presence of innumerable varieties, occurrence of near relatives, particularly teosinte, and corn remains found in ancient burials and ruins point to the American origin of the plant. Bonafus in 1836, and Stonor and Anderson in 1949 found evidence indicating maize was in Asia before 1500 (Weatherwax, 1954, pp. 132-138). The first two claimed its presence in China. De Condolle and Collins believe the plant was introduced in China after 1500 (Idem). Stonor and Anderson found it growing in Assam and upper Burma and the native population claims that it has been there since ancient times. In absence of written records and other evidences, however, its presence in Assam and Burma since pre-Columbian days can not be established. Likewise there is no evidence to prove that it was not grown there before 1500 A.D.

It is not known where corn was first domesticated in America. The presence of its closest wild relative, teosinte, in Mexico and Central America Vavilov concludes that the origin of maize was in that area (Vavilov, 1950, p. 40). This view is also held by many others but there is no direct evidence to establish when and where the domestication of corn originated.

Although corn has wide latitudinal range, it is a warm-weather plant (Jenkins, 1941, p. 310). It does not germinate at temperatures
below 50° F. and does not grow in areas where the mean temperature is below 66° F. and night temperatures fall below 55° F. during the period of growth. Corn cannot withstand frost (Stubbs, 1886, p. 3) and needs about 140 frost-free days. It requires sunshine and abundant water well distributed throughout the growing season (Jenkins, 1941, p. 312). During the silking and tasseling periods water requirements reach a maximum. An average rainfall of three to six inches monthly during June, July and August brings optimum yield. Louisiana has these ideal conditions, but in East Pakistan the sun may not shine for many days during summer months.

Corn grows best in well-drained loam and silt loam soils. Although the yield is not as good, it also grows in lateritic soils. Louisiana corn is produced in well-drained alluvial soils, bluff and terrace soils, and hill soils. Because of the low value attached to corn in East Pakistan it is grown primarily in the less fertile soils of the Pleistocene terraces, and in the Tertiary hills by tribal inhabitants. In other areas corn is a garden crop.

Sowing of corn in Louisiana begins in March and continues until May. Planting is done in rows by corn planters. For good yields, the crop is cultivated every week from the time that corn plants become one inch high until they are three feet tall (Wasson and Kilgore, 1956, p. 7-8). Harvesting begins in August in the extreme south but in most areas corn matures in September.

In the early years of colonization corn was grown as food for slaves on almost all plantations of Louisiana. Later it became an important rotation crop with cotton and was extensively grown in the Florida Parishes,
on the bluffs along the Teche River, Macon Ridge, Red River Valley, Tensas River Basin and the Louisiana hill area (Fig. 44). The production peak was reached in 1940, when 1.6 million acres of land was planted into corn (Montgomery, 1956, p. 38). Acreage decline has since been rapid primarily because of the soil conservation program. In 1955 little more than one-half million acres were planted into corn.

**Sugar Cane**

Since prehistoric times sugar cane has been used for the manufacture of brown sugar (gur) in East Pakistan. A simple way of extracting the juice was to cut the cane into short lengths and crush them in a stone or wooden mortar with a pestle, powered by oxen (Geerlings, 1912, pp. 51-52). A mill with two vertical wooden rollers was later introduced. Early in the present century the wooden rollers were replaced by iron cylinders with geared wheels and are called Behea Mills.

Once the juice is extracted it is boiled in a shallow iron pot over a furnace of dried mud (Fig. 45). Dry leaves and crushed cane stalk are used as fuel. Skill is required both in regulating the temperature and in clarifying the boiling juice by means of various decoctions. Sometimes the operation is carried out by professional sugar boilers. "Gur" Manufacturing is conducted during the dry winter months. Usually a plot of land cleared of sugar cane is selected and levelled. The mill is located in the center of the clearing and the furnace in a corner; a small hut is erected close to the furnace for guards and shelter from the sun for the workers.

In olden times "gur" was further purified by "seala" weed
Fig. 45 "Gur" (Brown sugar) Manufacturing.
Note the sugar cane field behind Dacca District.
(Vallisneria spiralis) or by mixing with milk (Hag, 1939, pp. 185-186).

Today the European method of crystal sugar manufacturing is used in some areas. Europeans tried to establish a sugar mill in East Pakistan as early as 1829 but it failed. The first successful mill was not developed until the 1930's. Today six sugar mills are in operation in East Pakistan.

For many years sugar cane was used primarily for syrup in Louisiana. After de Bore's successful manufacture of sugar in 1795, however, most plantations had their own mills. Most sugar manufacturing today is conducted by large mills and syrup manufacturing is no longer of great importance.

All available evidence indicates that sugar cane originated in India. The description of sugar cane is found in Indian mythological literature of 1000 B.C. (Geerlings, 1912, p. 3). Ancient Greek and Roman authors like Pliny, Strabo, Arrian, Theophratus and others describe sugar cane as honey collected from reeds grown in India (Majumder, 1938, p. 207). Botanical evidence furnished by Vavilov points to the Indian origin of sugar cane (Vavilov, 1950, p. 29). Parthsarathy, after examining the cytogenetical aspects of sugar cane, concludes that the region of its original growth was on the slopes of the Himalaya Mountains (Parthsarathy, 1951, p. 66).

From India the usage and growth of sugar cane spread both eastward and westward. In 627 A.D., the Arabs conquered Iran where sugar cane was grown and are responsible for its spread throughout the Mediterranean to Spain. Early in the 15th century the Spaniards and Portugese introduced cane in the Canaries, Azores and Cape Verde Islands. On his second voyage to America, Columbus brought sugar cane plants from the Canary Islands to
start sugar cultivation in San Domingo. The first attempt failed but by 1510 sugar cane was successfully grown in the western hemisphere.

The first mention of sugar cane cultivation in Louisiana was made in 1725-26. Seed was brought from San Domingo (Glenk, 1934, p. 27) and after several early attempts failed de Bore achieved success in 1795 and manufactured sugar on a commercial scale. Since then sugar cane has been as important crop of Louisiana.

Sugar cane grows best in a temperature of 75° to 80° F., and little or no growth takes place at temperature below 50° F. Frost is dangerous to young cane and severe frosts during the period of ripening causes inversion of the sucrose. Sugar cane needs a minimum of 250 frost-free days. All of East Pakistan and sections of Louisiana south of the 31° North latitude line have this necessary requirement for sugar cane cultivation.

Sugar cane requires a considerable amount of moisture, particularly during vegetative growth, and is sensitive to drought conditions. Stagnant water is damaging also and hence both ample water and well drained soil are essential. Weather during the ripening period should be relatively dry in order to maintain a high quality of sucrose.

The vegetative growth of cane in East Pakistan and Louisiana takes place in summer during which heavy rainfall occurs in both areas. Supplemental irrigation is helpful but it is not practiced in East Pakistan during the summer months. Decrease of rainfall in both areas in the fall coincides with the maturing of the cane and maintains the quality of sucrose.
Sugar cane is grown in a variety of soils ranging from sandy loams to heavy clays, but silt loam and clay loam are more suitable (Barnes, 1953, pp. 52-53). Sandy loams need a liberal application of fertilizer and backswamp clays need proper drainage. In East Pakistan it is grown on both alluvial and red soils; the red soils, however, require application of potash, lime and nitrogen. Because of the scarcity of fertilizer and deficiency of water for irrigation, sugar cane cultivation on red soils is limited.

In preparation for planting, the land is plowed and manured in February and March. Cane cuttings are planted in furrows one foot apart and covered with ash and dried water hyacinth (Fig. 46). Irrigation begins the day of planting and continues every fifteen or twenty days until the rains begin. During the first six months, constant weeding and occasional hoeing are needed. Harvesting begins in December and is completed by April; it is usually cut with a hoe (Fig. 47).

The planting season of sugar cane in Louisiana extends from August through March. Deep planting (about 8 inches) is required for fall-planted cane to protect it from frost (Taggert and Simon, 1957, p. 11). Harvesting which begins in mid-October and continues through December is primarily done with machinery. After the cane is cut it is loaded on trucks (Fig. 48) and transported to the sugar mill.

Over 50 years ago, sugar cane was grown in most Louisiana parishes but the severe climate in the north and the planting of crops more suitable to terrace soil reduced sugar cane acreage (Plate XII B). Five
SUGAR CANE
1950-54
ONE DOT REPRESnets 1,000 ACRES

SOURCE OF DATA: GOVERNMENT OF EAST BENGAL
AGRICULTURAL & ANIMAL RESOURCES OF EAST
BENGAL, 1953
L O U I S I A N A
SUGAR CANE
1950

ONE DOT REPRESENTS 1000 ACRES

SOURCE OF DATA:
U.S. CENSUS OF AGRICULTURE, 1950
Fig. 46  Sugar cane planting. Note the planting of the cuttings in the furrows. East Pakistan

Fig. 47  Sugar cane harvesting with the hoe in East Pakistan.
Fig. 48 Sugar cane being unloaded from the two-wheeled trailer which hauls the cane from the field. The crane loads the cane on trucks which transport it to the mill. West Baton Rouge Parish, Louisiana.
million tons of sugar cane were produced yearly by 1910 (Montgomery, 1956, p. 19); disease reduced production to 47,000 tons by 1926 (Taggert and Simon, 1957, p. 8). Hybrid sugar cane from Java and two varieties from India were more adaptable to Louisiana conditions and produced higher yields than the varieties formerly planted. Louisiana has less acreage planted in cane today than in 1910 but the yield is higher (Montgomery, 1956, tables 5 and 6).

Tea

The tea plant (*Camellia sinensis*) probably originated in southeastern Asia. It is found wild in southwestern China, northern Burma, Assam and eastern districts of East Pakistan. It was first domesticated in China. The history of tea plantations in East Pakistan begins in the 19th century (Sattar, 1954, p. 19). Tea plantations were established in Assam in 1851, in Sylhet in 1854, and in Chittagong in 1862 (Hunter, 1908, p. 56; Sattar, 1954, p. 19).

The tea plant is hardy but for proper growth, the temperature should not fall below 55° F. Tea plants survive cool winters and dry periods but growth stops during these periods. Tea plants require abundant moisture, and in East Pakistan are grown on hills where rainfall is 100 inches annually.

The quality of tea is influenced by the soil where it grows. Clay soils produce a strong scent but a poor flavor, tea grown in soils rich in organic matter, has a sweet taste but a poor aroma, and sandy loams impart a favorable balance of taste and aroma to the leaves (Wickizer, 1951, p. 174). Tea plants require three essential elements in fertilizers:
potash, phosphorus and nitrogen (Morrison, 1954, p. 15). The first two are needed for the general health of the plant, and the latter for producing a good leaf crop. Ammonium sulphate is one of the best nitrogenous fertilizer (Harler, 1949, pp. 21-25), and is utilized in East Pakistan tea production. Mustard oil cake and cow dung are also used.

When a new tea plantation is being prepared the trees covering the land are felled in December and burned in February. The land is then hoed, cleared of weeds and terraced. Year old seedlings are planted four to five feet apart and thereafter pruning, weeding, hoing, manuring and spraying insecticides are part of the normal care for the plants. Pruning restricts the tea plant to a manageable height of four to five feet; otherwise it would attain a height of forty to fifty feet. Pruning the bush enlarges the plucking surface and yields a greater number of young leaves (Fig. 49). Tea plants are pruned during the winter every two or three years.

Harvesting leaves from a new tea plant begins during the third year of growth and continues for several decades. Leaves are hand picked every eight to ten days from April to December by women and children.

The preparation of green tea is a relatively simple process and consists of heating, rolling and drying the fresh leaf without allowing it to ferment. When black tea is produced leaves are dried (withered) eighteen to twenty-four hours and then rolled by machines which break open their cells and frees the juice to allow the fermentation required for flavor. Fermentation is controlled by quickly drying the tea in
Fig. 49  A tea garden in Sylhet district. Note the level, circular top after pruning.
copper pans over a fire. It is then termed "made" tea and is ready to be assorted, blended and packed for shipping.

Tea is the only commodity in East Pakistan produced on the plantation system; the average size of a plantation is 560 acres. The industry employs many workers for cultivating and harvesting tea. Social classes are well defined from the manager to the tea picker. A tea plantation includes the tea fields, factories, warehouses, administrative buildings, and homes. Most tea plantations are in the Sylhet District and are concentrated in the southern and northeastern sections (Plate XIII A). A few plantations are located in the Chittagong and Tippera Districts.

A total of 75,000 acres are divided among 133 tea plantations (Government of East Pakistan, 1956, p. 66). The total production of tea is a little over five million pounds annually.

Cotton

Cotton belongs to the genus Gossypium of which there are several cultivated varieties. According to Hutchinson, Silow and Stephens the origin of Gossypium herbaceum and Gossypium arboreum was in the Indus Valley (Hutchinson, Silow and Stephens, 1947, pp 11-15). Vavilov believes Harbecuem originated in Central Asia (Vavilov, 1950, p. 29) and arboeum was found in the ruins of Mohenjo-Daro (West Pakistan) which has been dated at 2700 B. C. Cotton cultivated in the United States belongs to the Gossypium hiraum and barbadense species. The origin of the first species was in Southern Mexico and Central America, and the barbadense species was first grown in the Peru, Ecuador, and Bolivian area (Vavilov, 1950, pp. 39-41). Cotton was brought to Louisiana from Mexico and was
planted first by the Houma Indians (Glenk, 1929, p. 26). By 1773 the colonists successfully produced cotton near New Orleans, but the real expansion of cotton cultivation awaited the invention of the cotton gin.

The cotton plant is a native of warm climates and requires about 200 frost-free days (Brown, 1956, p. 6). The plant grows poorly in temperatures below 60° F. but attains optimum growth in areas with an average temperature of 70° F. to 72° F. during the growing period (Doyle, 1941, p. 350). A minimum rainfall of twenty inches a year is desirable with seven to eight inches well distributed over the growing season. A dry fall is a requisite for ripening and harvesting. Louisiana temperatures and rainfall during cotton growing season are excellent optimum conditions. Rainfall in autumn is more than the optimum but it is not enough to cause great damage. The best soils for cotton are composed of equal proportion of sand, silt and clay, combined with organic matter and nitrogen, phosphorus and potash (Brown, 1956, p. 6). The best soils for cotton in Louisiana are the Red and Mississippi River bottoms, bluff and terrace soils. Cotton planting begins by mid-March with horse or tractor drawn planters. A few farmers use a flame cultivator to burn weeds and grasses at the base of the plant but not the plant itself. Cotton picking begins in August and continues through December. It is generally picked by hand but in recent years the mechanical cotton picker has come into use.

During the early years cotton cultivation was confined to Natchez, Mississippi area and southward along the Mississippi River (Gray, 1941, vol. I, p. 77). Expansion was slow because of the difficulty in separating the lint from the seed. About the middle of the 18th century, Dubreil invented a
gin of the roller type. This promoted the expansion of cotton acreage to some extent but the real expansion awaited the invention of Whitney's gin in 1793. Cotton cultivation spread along Bayou Lafourche, Teche River, Red River, Tensas River, and in the bluff lands of the Florida Parishes. The industry suffered losses during the Civil War, but afterward expanded and its cultivation spread into the hills of Louisiana. By the end of the 19th century cotton was grown from the Gulf Coast to the Arkansas line. During the early years of the 20th century, Louisiana cotton was damaged by the boll weevil. This pest came from Mexico through Texas in 1892. The parishes to the east of the Teche River and south of the Mississippi River lost most of their cotton acreage (Montgomery, 1956, pp. 2-5), and did not regain it even during the cotton boom of 1930 (Fig. 50). The economic depression and the following Agricultural Adjustment Act cut the state acreage of cotton considerably. Former cotton lands are now pastures or forests.

The awareness of soil erosion and the remedial growing of grasses is now a general practice. Despite a cut in cotton acreage there has been an increased cotton yield because of improved agricultural practices and better varieties planted. In 1953, the yield of cotton was 419 pounds per acre, compared to 349 pounds in 1943, and 241 pounds in 1903 (Montgomery, 1949, pp. 6-17 and 1954, p. 37).

In East Pakistan cotton is a minor crop. Only a small quantity is produced in the Chittagong Hill Tracts. The flat lands remain too wet in the summer and adequate irrigation facilities are not available in the winter.
Fig. 50
Jute

Jute is extracted from the plant genus, *Corchorus*. It was first used for the manufacture of cordage (Hayat, 1950, p. 2) and later was spun and woven into coarse cloth and matting. Jute yarn is mixed with cotton, wool, silk, flax and other fibers to make curtains, upholstery, rugs, carpets and other items. Its greatest use is for cord and sacks which are cheaper, stronger and more durable than those made of paper, cotton, flax, or other fibers.

There are thirty-six of the genus *Corchorus* according to (Watt, 1889, Vol. 2, pp. 539-562). Only two, *Corchorus olitorius* and *Corchorus capsularis*, are cultivated. These two species are not closely related and cannot be crossed (Kundu, 1951, p. 95).

Watt, Macmillan, de Candolle, Vavilov and others believe India was the origin of *Corchorus olitorius* (Ibid, pp. 97-98). Kundu, however, points out that Africa has the greatest number of wild varieties of this species (Idem). Egyptians and Syrians were acquainted with this fiber before it was known to the Indians, hence he concludes that the origin of *Corchorus olitorius* was in Africa and that it came to India through Egypt, Syria and Afghanistan. Watt, Prain and others believe that *Corchorus capsularis* originated in South China where it is found in a wild state (Idem). Macmillan, Vavilov and Kundu say that its origin was in India where the largest number of wild species are found (Idem). In any event, it is evident that the origin of cultivated jute was in the tropical areas of the Old World. Although the exact time of the introduction of jute into East Pakistan is unknown, evidence indicates it was grown in the province in the 16th
In early times jute, which was hand spun on simple looms, was utilized for clothing, sacks and bedding. Production was only for local consumption before the 1790's when the East India Company used jute ropes for ships and later shipped jute sacks abroad (Currim, 1954, p. 20). The trade rapidly expanded and in 1850 thirty million yards of jute goods were exported. Numerous small handloom factories sprang up in the rural areas but these factories were short lived. Jute mills were established at Calcutta, Dundee Scotland and other places and handloom factories disappeared by the closing years of the last century. Large corrugated metal buildings were constructed for jute presses and warehouses. Today hundreds of these structures dot the rural landscape of East Pakistan.

Jute is essentially a crop of river levees and back slopes and does not thrive in the heavy soils of the "bil" areas and the red soils of the Pleistocene terraces (Fig. 51). It is not grown in the southern part of the province because of saline conditions. Cow dung is the basic fertilizer but in recent years good results have been obtained with applications of ammonium sulphate. Experiments conducted at the Dacca Farm indicate that the yield increases three times with the application of a combination of nitrogen, potassium and calcium (Bowers, 1949, p. 93). The farmers, however, continue to depend heavily upon the natural renewal of soils by river inundation every year.

Jute fields are cross-plowed five to six times and manured and fertilized before the seed is planted. Lowland jute is planted in late February to enable the plants time for adequate growth before the summer floods. Jute seed is broadcast once lengthwise and once crosswise. Thinning is required
EAST PAKISTAN
JUTE
1950-54
ONE DOT REPRESENTS 2,500 ACRES

SOURCE OF DATA: GOVERNMENT OF EAST BENGAL
AGRICULTURAL & ANIMAL RESOURCES OF EAST
BENGAL, 1955

Fig. 51
and weeding is continuous until the plant reaches the height of two feet. After that jute plants require little care until they are eight to ten feet tall and ready to harvest.

Harvesting begins in June and continues through September. Plants are cut, tied in bundles and allowed to dry for a few days until the leaves drop off. The bundles are then submerged in water from ten to twenty days. This process, called retting, ferments and separates the pith from the fiber. The fiber is removed from the stock by beating it with a wooden paddle or thrashing it on the surface of the water. It is washed, dried on bamboo frames, tied in bundles and marketed.

Jute distribution in East Pakistan is determined largely by soils, topography and nor'wester rainfall. The greater number of jute fields are on flood plains of Dacca, Tippera and Mymensingh Districts (Fig. 51) which receive heavy rainfall from nor'westers. In addition, the Meghna River, which flows through this area, is clearer and has less mineral content than the Ganges and Brahmaputra Rivers and is therefore better for the jute retting process.

Fruits and Vegetables

Some fruit grown in East Pakistan and Louisiana is common to both areas. For some Louisiana farmers fruit is the basic crop whereas in East Pakistan fruits are grown primarily in home gardens.

East Pakistan produces a number of tropical fruits: citrus fruit, jackfruit, banana, mango, pineapple and coconut. Oranges and lemons are the only important citrus fruit. Both of them are indigenous to the Assam hills and adjoining parts of Burma and China (Bhattacharya and Dutta,
1951, pp. 57-61). Oranges are grown primarily by tribal people in the Sylhet District; lemons are grown in all sections of the province.

Bananas, both the fruit (*Musa sapientum*) and plantain (*Musa paradisiaca*), are widely grown in East Pakistan. According to Cheesman, bananas originated in India (including East Pakistan) and Malaysia (Chakravorti, 1951, p. 35); Vavilov believes they originated on the islands of Southeast Asia. Bananas are primarily grown in home gardens; commercial bananas are produced only in a small area of Munshiganj Subdivision (Dacca District).

The coconut (*Cocos nucifera*), according to de Candolle originated in the islands of Southwest Asia (de Candolle, 1886, pp. 55-57). Cook believes it is a South American plant because of the diversity of wild species and because it was growing there in pre-Columbian time (Kaul, 1951, p. 108). However most authorities, including Vavilov, consider Southeast Asia to be the original home of the coconut. It was probably introduced in East Pakistan by Archaic Caucasoids during Neolithic times (Chatterjee, 1951, pp. 147-151). Today it is widely grown in the partially saline areas of East Pakistan (Fig. 20).

De Candolle, Vavilov, Mukherjee (Mukherjee, 1951, pp. 40-55), and others are of the opinion that mangoes (*Mangifera indica*) originated in southwest Asia. They were introduced to East Pakistan in the remote past and many varieties of mangoes are grown, particularly in Rajshahi, Jessore and Kushtia Districts. Some vegetables grown in East Pakistan are indigenous and some have been introduced from various parts of the world. Eggplant, cucumber, lettuce, radish and gourd are either indigenous to East Pakistan or have been introduced from nearby areas. Tomatoes, potatoes, and
red peppers and pumpkin were introduced from America.

Louisiana produces a number of tropical and subtropical fruits; although some fruit is indigenous to the area many varieties have been introduced from other regions. In the early years of the 10th century Arabs introduced oranges into North Africa and southern Europe (Bhattacharya and Dutta, 1951, p. 59); Spaniards brought them from Europe to San Domingo in the early years of their settlement and they were introduced into Louisiana by the Jesuit Fathers in 1840 (Glenk, 1939, p. 35).

Oranges were first grown near New Orleans and their growth later spread to all parishes of South Louisiana. In 1914 a large number of citrus trees were burned to stop the spread of citrus canker \( (\text{Phytoponas citris}) \), a bacterial disease (Bederman, 1957, p. 4). In 1929 a severe frost destroyed a large number of trees in Beauregard and St. Tammany Parishes. The citrus industry has since declined in all areas except Plaquemines Parish where it is concentrated today. In recent years, the petroleum industry has attracted laborers from the orange groves and consequently, several groves have been abandoned. Some have been converted to trailer parks to house workers from nearby industries. Thus the landscape is undergoing a marked change.

Wild strawberries, from which cultivated varieties have developed, are found in the temperate zones of both hemispheres. \( \text{Frageria vesca} \) of Europe, \( \text{Frageria virginians} \) of eastern United States, and \( \text{Frageria chiloensis} \) are cultivated varieties. The first garden culture of strawberries started in France early in the 14th century (Fletcher, 1917, pp.
By the close of the 16th century strawberries were common in English gardens. Strawberries were growing wild in Louisiana when the Europeans came. During the early days of settlement domestic strawberries were grown near New Orleans (Fletcher, 1917, p. 57). By 1880 strawberries were produced for commercial purposes in Tangipahoa Parish. Expansion of the industry did not come until the availability of refrigerator care (1893) and the development of the Klondike variety (1901) which have better shipping qualities (Hopper, 1932, pp. 21-23). Strawberry production spread to the adjoining parishes of Livingston and St. Tammany and those areas are still important strawberry centers.

The peach which is native of China, spread into Persia by the 5th century B.C. (Glenk, 1934, p. 34). From Persia it was taken to Greece by Alexander the Great and from there spread into Europe. It was brought to the United States by the early settlers of the Carolinas and Virginia. By the time Europeans came to Louisiana peaches had already reached the state. Peach trees grow all over the state but are mainly concentrated in north Louisiana where they have replaced cotton on many farms (Barlow, 1945, p. 28). Peach trees control soil erosion of hilly areas and also grow better in cooler parts of the state.

Among the vegetables grown in Louisiana, tomatoes, red peppers, Irish and sweet potatoes, and several varieties of beans are Indian contributions. Europeans brought cucumbers, eggplants, radishes, and others from various parts of the world.

**Crop Combination Regions**

Subsistence agriculture is practical in East Pakistan with rice,
PLATE XIII

EAST PAKISTAN
CROP COMBINATION REGIONS

SOURCE OF DATA: AGRICULTURAL STATISTICS
BY PLOT TO PLOT
ENUMERATION IN
BENGAL, 1944-45
LOUISIANA CROP COMBINATION REGIONS (AFTER PHILLIPS)

- MILL COTTON - CORN
- RED RIVER COTTON
- MISSISSIPPI RIVER COTTON
- CUT-OVER
- RICE
- SUGAR CANE
- CENTRAL LOUISIANA DIVERSIFIED
- FLORIDA PARISH DIVERSIFIED
- TRUCK - CITRUS FRUIT
- ATCHFALAYA SWAMP
- MARSH
which is grown on eighty-two per cent of the farmed area, as the chief crop. In addition, each farmer tries to grow a small cash crop to purchase other necessities. Cash crops differ from area to area according to the changing topography, soil and climate. A number of crop regions have combinations of rice and some cash crop (Plate XIII A). In diversified farming regions, several crops other than rice are equally important. They are jute, pulses, oilseeds, tobacco and sugar cane.

Within the last 250 years of plow agriculture, the crop complex of Louisiana has been in constant change. Changes have been brought about by improved technology, better knowledge of soils and climate, and changing values. Southwestern Louisiana became the major rice-growing area after construction of canals and artesian wells, and the introduction of combines. Sugar cane which was once grown all over the state is now confined to areas with 250 frost-free days. In the early years of colonization, indigo and tobacco were major crops planted to meet the needs of France. Small farms practiced subsistence farming and even large plantations produced enough food for their own needs. Today almost all farms are commercial. The rice farmer sells all his produce and then purchases rice for his own use from the supermarket. Certain crops have become important in certain areas, and a number of crop regions have developed (Plate XIII B). The cutover land region is primarily a subsistence crop area. It is a region of poor soil, rugged topography and low yields. Soybeans, sorghum, potatoes, peanuts, some hay crops, corn and cotton are all grown.

Red River cotton areas, Mississippi River cotton areas, and sugar
cane regions converge in the Central Louisiana Mixed Farming Region. It is a transitional area and almost equal emphasis is placed on all crops grown.

The Florida Parishes have level topography and flatwood soils in the south and rugged topography and hill soils in the north. The soil is poor but when fertilizer is added good truck crops and strawberries are grown in the south. The tung tree, an indigenous plant in Louisiana, is important in the northeast and pasture is another notable land use. Cotton and corn acreage have been reduced but are still significant in these regions.

Farming in the Atchafalaya Swamp region is confined to abandoned natural levees and is primarily a subsistence nature. The marsh along coastal Louisiana is utilized as grazing and trapping areas.
Domesticated animals in East Pakistan date back into Neolithic times. Pigs and chickens originated in southeast Asia; cattle, goats and sheep were introduced from the Indus Valley (Sauer, 1952, pp. 92-96). There were no domesticated animals in Louisiana except the dog, until the Europeans introduced farm animals. Animals are utilized differently in East Pakistan than in Louisiana. For example, cattle are mainly draft animals in East Pakistan, but are grown as meat and dairy animals in Louisiana. The cultural heritage of both areas is the causitive factor in explaining the different usage of domesticated animals by the people of the two regions.

**Cattle**

Cattle are generally divided into two groups; *Bos primigenius* or European cattle, and *Bos indicus*, or Indian cattle (also called zebu or humped cattle). The first domestication of cattle was in southwest Asia (Sauer, 1952, p. 85). The oldest bones of cattle, sheep, and goats are found in village sites of central Iran and the upper Mesopotamia Valley. In all probability, cattle were first introduced into the European countries of Crete and Greece from Mesopotamia, from whence they spread onto the mainland through the Morava-Vardar gateway (Boston, 1956, p. 22). Later, cattle spread from Egypt to Spain, France and Britain. Several breeds of cattle were developed in Europe to serve different purposes, particularly in the countries bordering the North Sea.

Spaniards brought cattle to Mexico and the West Indies in 1525 (Allen, 1887, pp. 29-30). About 100 years later the English and Dutch
introduced cattle to the northeastern areas of the United States. The French brought Spanish cattle from San Domingo when they came to Louisiana and it was not until after the Civil War that other European breeds were introduced (Post, 1933, p. 563). Some breeds did not thrive in Louisiana's humid summers and hence Zebu cattle, known in America as Brahman, were introduced from the Indo-Pakistan subcontinent in 1867 (Curtis, 1893, pp. 211-212). Zebu cattle are well adapted to tropical and subtropical climates. Several breeds of beef cattle have been developed by crossing Zebu with European types.

Zebu cattle are the only types found in East Pakistan (Fig. 52). They were first introduced in the province by the Dravidians (Chatterji, 1951, pp. 156-160). In India and West Pakistan many improved varieties have developed, but only indigenous nondescript cattle or scrub types are found in East Pakistan. Only recently have some Red Sindhi been brought from West Pakistan for breeding purposes (Joshi and Phillip, 1953, p. 181).

There are about 14.6 million cattle in East Pakistan (Govt. of East Bengal, 1956, p. 81). They are used primarily as work animals but some are also utilized for dairy products and meat. The total consumption of milk products is negligible; it amounts to about forty pounds per individual annually. Milk as a beverage is uncommon and is used mostly by invalids and a few urbanites. Milk is usually made into butter oil ('ghee'), yoghurt ('dahi'), evaporated milk ('khoya'), butter and coagulated milk ('chena'). The mongoloid tribal inhabitants of the Chittagong Hill Tracts do not drink milk at all. The dairy industry is operated
Fig. 52  Zebu cattle of East Pakistan. Note the earthen bowl used for feeding and watering the cattle.

Fig. 53  Two-wheeled Bullock cart in East Pakistan.
by the 'goala' caste who live near urban market centers.

Cattle are also used for meat, but meat is more of a luxury than a common food. Although the annual consumption of beef per individual is only eight pounds, beef accounts for more than eighty per cent of the total meat consumed (Govt. of East Bengal, 1956, p. 94). Muslims eat beef; the tribal inhabitants eat beef occasionally on festive occasions; and Hindus do not eat beef at all.

Cattle are mainly used for pulling plows, carts (Fig. 53), and other implements (Figs. 6 and 7). The average cultivator's bullock is a starved and stunted beast. Tillage implements are light in weight and good cultivation is possible only in easily worked soil. Bullocks are the main work animals and are better fed than cows. The cows are low milk producers and are kept mainly to reproduce bullocks.

In densely populated rural areas there is competition for land between crops and animals. Crops support more people per acre and are therefore given preference. Grazing land is less than 0.1 per cent of the total tilled land and pastures are not a part of the agricultural pattern. Cattle are mainly fed on rice straw (Fig. 54). Peas and "khesari" (pulse) are used for fodder in small quantities. Sometimes farmers reap the grass growing on river banks, roadsides or the ridges between fields. The monsoon season is a lean period for cattle. Fields are either under water or planted with crops; the straw supply is scanty and cattle are often without food.

Water buffalo are found in small numbers in East Pakistan; they make up three per cent of the total cattle population. The water buffalo
was probably domesticated in the Indus Valley. At Mahenjo Daro bones of buffalo about 5,000 B.C. old have been found (Wheeler, 1953, p. 60). The buffalo was introduced to East Pakistan at the same time as cattle. As milk and work animals, buffalo are superior to cattle, but they require more care and food. Hence in this area where man competes with animal for food, the buffalo loses to inferior cattle.

In Louisiana cattle were used as draft animals only during the first few years of colonization and were soon replaced by mules and horses. Today cattle primarily serve as a source of meat and milk. Each cow yields an average of 2,500 pounds of milk per year in Louisiana, compared to an average of 410 pounds of milk per year in East Pakistan. The annual consumption of milk per person in Louisiana amounts to 260 pounds and beef to 134 pounds (Montgomery, 1954, pp. 20-23), as compared to 40 pounds of milk and 8 pounds of beef per individual in East Pakistan.

The main types of dairy cattle are Holsteins, Jerseys, and Guernseys. The Holstein was introduced in the United States by the Dutch in 1877 (Curtis, 1893, p. 118). This breed was first nurtured in north Germany and later in Holland. Jersey and Guernsey cows were imported to America from the Channel Islands in 1830. Jersey cattle are preferred in Louisiana because of their tolerance for heat.

Most Louisiana dairy farms are located near cities but with the use of refrigerated trucks it is now possible to locate the dairy industry further away from urban areas. A truck, once charged with ammonia, can retain the proper temperature for about six or eight hours (Fig. 55). The dairy industry in Louisiana is largely concentrated in the vicinity of
Fig. 54 Stack of rice straw. Note the cleared area used for threshing rice.
Fig. 55  Trucks being charged with ammonia at Kleinpeter Dairy Farm, East Baton Rouge Parish

Fig. 56  Kleinpeter Dairy Farm, East Baton Rouge Parish. Note the silo and the hip-roof milking building
Fig. 57  Milking machine. The rubber tubes are attached to plastic tubes which carry the milk to the bulk tank. (Vide Fig. 58).

Fig. 58  Guernsey cattle being milked by combine milker. Note the tubes through which milk goes direct to bulk tank in another room.
Dairy farms impart a distinct pattern to the agricultural landscape of Louisiana. Silos, barns, milking buildings and milk processing structures are characteristic of dairy farms (Fig. 56). Machines for milking and processing are used in Louisiana compared to hand labor in East Pakistan. Some Louisiana farmers use combine milkers which carry the milk directly from the cow to bulk tanks through tubes (Fig 57 and 58). All milk is pasteurized whether or not it is used as a beverage or made into butter, cheese, butter milk or cream.

Hereford, Angus, Brahman and their crossbreeds are the main beef cattle of Louisiana. The Hereford type was developed in Herfordshire, England, in the middle of the 18th century by crossing red local cattle with white Wales cattle (Hazelton, 1925, pp. 4-6). Herefords were introduced in the United States in 1840. Angus was native of Scotland and was introduced in the United States in 1873 (Curtis, 1893, pp. 196-198). Brahman cattle were first imported after the Civil War. They are cross-bred with European cattle and the Brahman-Angus cross-breed produces a good beef animal.

Beef cattle fit well in the rotation program of Louisiana crops, particularly in rice and cotton areas. Many abandoned cotton farms in the Florida Parishes, and hill areas of Louisiana, and sugar cane farms along the Mississippi River are used for cattle ranches. Beef cattle are also grazed in the coastal marshes, particularly in Vermilion and Cameron Parishes. Beef cattle populations have increased during the last 25 years and this trend will likely continue.

Cattle are better fed and cared for in Louisiana than in East-
Pakistan. In 1954 approximately one-third of the Louisiana farm area was pasture land and 22 million acres of woodland were pasture and only 675,000 acres of woodland were pastured. Considerable amounts of alfalfa, clover, lespedeza and other legumes from the Mediterranean area and southwestern Asia are produced for animal feed. Cattle meal is also made from mixtures of corn, oats, barley, mineral mixtures, proteins, legumes and other hays. Cattle are fed and watered in the barn or in a number of mangers and water troughs scattered throughout the pasture (Fig. 59, 60, and 61).

Goats and Sheep

The home of the goat (Capra) was in southwest Asia. The domesticated type apparently has descended from the Capra aegagrus, a mountain animal found from the Indus Valley to the Caucasus Mountains (Sauer, 1952, p. 91). Sheep (Ovis aries) were also domesticated in the same general area. Their chief ancestor Ovis vignei is found in West Pakistan from the Salt Range to Baluchistan (Sauer, 1952, p. 92). Goats and sheep were introduced into East Pakistan along with cattle. Goats are present in large numbers (4 million), but sheep are unimportant (.23 million).

The goat is a scavenger and can live on grass growing along roadsides, 'khals', and river banks. Since it does not need much pasture nor great care the goat has become a common animal in rural East Pakistan and most farmers raise a few goats. It is unimportant as a meat or dairy animal to the farmer but goat is an important food for many urbanites and brings ready cash on the market.

Goats and sheep were introduced in Louisiana in 1728 but are unimportant animals in the state today (Post, 1933, p. 565). Because of the warm
Fig. 59 Cattle hay manger in open field.
East Baton Rouge Parish.

Fig. 60 Feed shed for mixed grain. East
Baton Rouge Parish.
Fig. 01  Water trough on a Louisiana farm.
East Baton Rouge Parish

Fig. 02  Horse drawn plow. Acadia Parish
climate the amount and quality of wool obtained is low (Randell, 1880, p. 17) and mutton is not a favored meat. Sheep are used however, on some sugar cane plantations to control Johnson grass. Beauregard is the only parish were sheep are now found in appreciable numbers.

Pigs

The pig was first domesticated in southeast Asia, from a wild ancestor (Sus vittatus) (Sauer, 1952, pp. 31-37) and was originally a household animal. It spread to India and thence across the Mediterranean Sea to western Europe during Neolithic times. In Europe another wild pig (Sus scrofa) was domesticated. The pig was brought to Louisiana from San Domingo during the early years of European colonization (Post, 1933, p. 565).

The pig type first introduced into Louisiana was the Cochrus marrows; it was probably the ancestor of the present day semi-wild razorback. Present Louisiana farmers favor the Duroc, Poland China and Chester White breeds (Fitzgerald, 1956, p. 3). All of these are large animals and were developed about the middle of the 18th century: Duroc was developed in New Jersey; Poland China in Ohio; and Chester White in Pennsylvania.

Pigs are most numerous in Louisiana on the diversified farms of the central part of the state, with the greatest concentration in St. Landry and Lafayette Parishes. They are distributed in considerable numbers in the Red River Valley and the Tensas River Basin, but are less numerous in the hill areas of Louisiana, Florida Parishes and the prairie area. Few are grown in sugar cane regions or in the marsh area. Pig farms are characterized by moveable shelters for the sow and her litter, farrowing houses, hog wallows and self-feeders.
Pork was eaten in East Pakistan before the Hindu Aryans came but is now prohibited by all but the low caste Hindus, who are converts of the pre-Aryan people. The Islamic religion also has taboos against eating pork and after Muslims came to East Pakistan, the pig became even more scarce. The Mongoloid folk in the Chittagong Hill Tracts are among the few pork eaters in the province.

Horses and Mules

The major breeds of the domesticated horse (Equus Caballus) are probably derived from cross-breeding tarpen stock and heavier forest breeds of western Europe (Sauer, 1952, p. 95). They were first domesticated in the northern part of the Caucasus mountain region or Central Europe. From there they spread into the Indus Valley (Wheeler, 1953, p. 60) and thence to East Pakistan. The Indians of Louisiana had received the horse from the Spanish before the arrival of the French (Post, 1933, p. 561).

A mule is a cross between a horse and an ass. In Ethiopia, long before 3,000 B.C., an ass had been domesticated from the wild ass of Nubica (Childe, 1951, p. 103). The mule was bred in the fertile crescent area of Mesopotamia and reached Louisiana via Europe as did the horse. During the ancient times horses were used for military purposes; in the late Bronze age they pulled war chariots and carts. For centuries horses have been used for similar purposes in East Pakistan. As far as is known, the horse has never been used to draw a plow.

Before the horse reached Louisiana it was a familiar animal to the European farmer and the early Louisiana settlers continued to use it as a work animal on their farms. Before the tractor was introduced during
World War I, horses and mules were the chief source of farm power (Fig. 62). Tractors gained importance and since World War II have replaced animals for the major farm chores. With the expanding cattle industry the "cow pony" has become an important animal in the state. The concentration in horse breeding has changed from work animals to specialized breeds of riding horses. The horse in Louisiana is used not only for work but also for pleasure and sports and it will likely remain an important animal in the agricultural landscape of Louisiana.
SUMMARY

East Pakistan and Louisiana exhibit marked parallelism in physical characteristics, but differ in cultural heritage and agricultural patterns. Consequently it may be inferred that the differences in agricultural patterns are primarily because of differences in their cultural background.

East Pakistan and Louisiana both have Tertiary hills, Pleistocene terraces and Recent flood plains. In East Pakistan the Tertiary hills are less extensive and more rugged than those of Louisiana; the Pleistocene terraces are smaller in area, but the Recent flood plains are twice as large as those of Louisiana and have greater percentage of arable land.

The soil of East Pakistan and Louisiana was derived from Tertiary rocks, Pleistocene sediments and Recent deposits. Tertiary rocks and Pleistocene sediments yield mature soil which has been oxidized and leached to a considerable extent. Therefore, these areas are deficient in plant nutrients and are agriculturally poorer than the flood plain. Recent deposits laid down by the Ganges-Brahmaputra systems and the Mississippi River represent areas of immature alluvial soil. This soil is agriculturally rich particularly on natural levees. In East Pakistan the greater part of alluvial soil is annually inundated and the soil is greatly enriched. No such phenomenon presently occurs in Louisiana because artificial levees and drainage basins control the river systems.

The climate of East Pakistan and Louisiana have certain characteristics in common. Summers in both areas are hot and humid, but winter conditions are different. Winter is cool and dry and no frost occurs in East Pakistan.
Louisiana is comparatively colder and frost occurs every year which prevents a winter growing season. East Pakistan enjoys a year-round growing season but few crops can be grown in winter without irrigation.

Cultural backgrounds of East Pakistan and Louisiana are different. East Pakistan was first inhabited by Negrito hunters and gatherers. During Neolithic times they were displaced and assimilated by Archaic Caucasoids who introduced dibble and hoe farming and a number of crops. The Dravidians who followed brought the plow and cattle. The mass migration of Hindu Aryans to East Pakistan took place during the 4th century A.D. They introduced the caste system, taboos against meat, particularly beef, and land ownership.

Muslims penetrated East Pakistan in the 13th century and revived beef eating, but imposed greater restrictions on pork. Following the Muslim arrival a great extension of agriculture took place and the land system initiated by the Aryans was crystalized. The Aryans and the Muslims, however, did little to introduce new plants or to bring technological changes in agriculture. By the end of the 15th century East Pakistan came in contact with Europeans and in 1757, was occupied by the British. Europeans introduced a number of plants from the New World (i.e. tobacco and corn) and plantation agriculture in tea gardens. The British did not disturb the general pattern of agriculture and did little to advance agricultural technology. They were primarily interested in tropical plantation crops produced by cheap labor.

Moreover, the East Pakistan farmers were unwilling to accept new ideas.

Prior to the arrival of the Europeans in 1700 A.D., Louisiana was inhabited by Indians who practiced dibble and hoe farming. Europeans introduced the plow and new field systems. They brought crops from the
Old World (i.e. rice and sugar cane) and farm animals (i.e. cattle, pigs, horses and mules).

East Pakistan is an "old land" with deep-rooted traditions. The people believe in predestination and are content with their lot. This has curbed the spirit of enterprise and makes adoption of new ideas difficult. The overwhelming illiteracy (seventy-nine per cent in 1951) and the division of society in functional groups have perpetuated the conditions of the past. During the British regime the British received the blame for all the evils of the country. Today one of the greatest problems of the national government is to convince the farmers of the need to accept technological advice.

Louisiana is inhabited primarily by people of European descent. Two groups are dominant: the French in the south and the English in the north. When they left Europe the Agricultural Revolution had already started. Close contact with the parent countries kept the immigrants informed about new developments. Moreover, the enterprising immigrants began to do research on plant and animal breeding, fertilizing practices and farm equipment. Today farmers look to the Agricultural Experiment Station for guidance and help.

In East Pakistan the land is plowed by the same type of ard used during the third millennium B.C., sowing is done by hand and harvesting by sickle. The tractor has taken the place of draft animals in Louisiana. Row crops are sown by mechanical seeders and others are sown by aeroplanes. Cereals are harvested by combines, cotton by mechanical cotton pickers and sugar cane by mechanical harvesters.
Fields are generally square or rectangular in both areas as required by plow tillage. But the specific pattern in Louisiana depends upon the people who have introduced the pattern. The French introduced the arpent system, the English an irregular field pattern and the General Land Office the square pattern.

Irrigation systems of the two areas are quite different and distinct. In East Pakistan "dheki kal", "don", and swing baskets are used and in Louisiana, sprinklers, siphon tubes and canals are the major methods for irrigation. Cow dung and oil cake are the chief fertilizers in East Pakistan; commercial fertilizers are in general use in Louisiana. The farm houses of East Pakistan and Louisiana are also different.

With the exception of buffalo, farm animals in the two areas are the same but differ in breeds. In Louisiana they are mostly of European breeds; in East Pakistan they are indigenous. The greatest difference lies in the ways in which the animals are used. Pakistani cattle are primarily draft animals, whereas in Louisiana, cattle are used for dairy and beef sources. Pigs, which are important as a source of meat in Louisiana, are insignificant in East Pakistan because of the religious taboos. Horses and mules are not used on Pakistan farms, but were the chief source of power in Louisiana before the introduction of the tractor. These differences in the agricultural landscape of East Pakistan and Louisiana can not be explained by physical factors. The few physical differences are too insignificant to cause a marked contrast in agricultural patterns. The absence of tropical fruits from the major part of Louisiana and the growing of rice in East Pakistan throughout the year may be assigned to
the climate. Distribution of crops within the two areas can be explained by regional differences in topography, soil and climate. The contrasting pictures of agricultural practices can be explained not by differences in physical features but by differences in the cultural heritage. This point becomes obvious when one examines other parts of the United States which are physically different from Louisiana but because of a common cultural background are similar in agricultural practices. Similarly, West Pakistan and East Pakistan are different physically but the agricultural practices are more or less alike.

Within East Pakistan and within Louisiana different cultural groups have caused differences in the agricultural landscape. The Mongoloid inhabitants of Chittagong Hill Tracts practice shifting agriculture, do not drink milk, eat pork and live in platform houses. In the major part of East Pakistan plow agriculture is practiced; fields are small and are rectangular or square in shape; and farm houses usually comprise four rooms facing a rectangular plaza. Tea plantations, a European enterprise, are large and have modern bungalows and good roads. The southern part of Louisiana where the French have settled Creole and shot-gun houses, and arpent field patterns are present. In Anglo-Saxon areas single and double log-pen houses appear and irregular field patterns are present. These differences are noticeable in areas which are physically similar but culturally different. The conclusion is inevitable that cultural and not physical differences are responsible for the different agricultural landscapes of East Pakistan and Louisiana.
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Glossary of Foreign Words

Ail: Low ridges between fields.
Amalguzar: Revenue officer.
Aman Rice: Winter rice, sown in June and harvested in November.
Ath-chala: Pyramidal roof structure with more than one room.
Aus Rice: Autumn rice; sown in March-April and harvested in August.
Baiads: Narrow river valleys in Madhupur Jungle.
Bali: Sand.
Banjar: Uncultivated land.
Bangla: Saddle-roof room.
Bargadar: Share-cropper.
Bari: House.
Barui: Hindu caste which grows betel gardens.
Bauri: Hindu farming-caste mainly cultivating towheads.
Bil: Low marshy area between natural river levees.
Biri: A small thin cigar.
Bhuiyan: High Caste Hindu, the landlords.
Boro Rice: Summer rice, sown in December and harvested in April-May.
Brahman: High Caste Hindu, the priest.
Buna: Hindu farming, caste mainly cultivating towheads.
Cachar: Land not cultivated for four or five years.
Char: Towhead.
Charadoba: Farming Hindu caste.
Chau-chala: Room with pyramidal roof.

Chena: Coagulated milk.

Dahi: Yoghurt.

Dao: A hatchet or hill knife.

Dhekikal: Irrigation technique of lifting water from wells or deep river channels by a bucket attached to a rope.

Dochala: Same as Bangla.

Don: A boat-like wooden trough used for lifting irrigation water onto the fields from "bils", canals or tanks.

Ghee: Butter oil.

Goala: Dairy caste.

Gur: Brown sugar.

Gram: Village.

Hukka: Hubble-bubble, a tobacco pipe so arranged that the smoke passes through water.

Jheel: Small depression or lake (same as bil).

Jhuminj: Shifting or dibble agriculture.

Kal Baisakhi: Nor'wester thunderstorms, literally calamities of the month of Baisakh (April-May).

Kamar: Blacksmith.

Khal: Small stream.

Kharis: Small entrenched streams of the Barind area.

Khatriya: High Hindu caste, the soldiers.

Khiaar: Red soils.

Khoya: Evaporated milk.

Klash: Vessel for storing water.

Koch: Farming Hindu caste.
Kopikal: Same as dhekikal.
Kurmi: Farming Hindu caste.
Lalmati: Same as Khiar.
Loo: Hot summer wind common in northern India.
Mati: Clay.
Moi: A wooden ladder-like implement to level lands and break clods.
Nala: A measurement of land about seven and one-half yards long.
Nangila: Wooden rake.
Nasaq: Land revenue assessment made by the common consent of the farmer and the state.
Para: Hamlet, in early days whole village was called para.
Parauti: Fallow land.
Patni: Hindu caste, boatman.
Polaj: Land under cultivation.
Postapala: Record keepers.
Raiyat: Tenant farmer.
Seunti: Swing basket used to lift irrigation water from a ditch onto field.
Silaris: A Hindu caste which protects crops from hail storms by magic.
Zabti: Regulation system of land revenue assessment.
Zamindar: Landlord.
Md. Fazle Karim Khan was born in Gaya District, India, in 1925. He passed the high school examination from Ranchi Zila School, India, in 1939. He received his B.A. (Hons.) from Patna University in 1943, and M.A. from Muslim University in 1945. He taught in several colleges of India and Pakistan, and in 1954 was appointed lecturer in Geography at Dacca University, Pakistan. He came to the United States in the fall of 1956 on a Fulbright Scholarship and attended two semesters at Kansas University, Lawrence, Kansas. In the summer of 1957 he transferred to the Louisiana State University where at present he is a candidate for the degree of Doctor of Philosophy.
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