The study of most modern Indian groups of highland Latin America would probably reveal relatively similar aspects of material culture in greater or lesser degree of European acculturation. The ethnogeographer, however, need not confine his interests to primitives or pre-technical societies. The same techniques and emphases of inquiry might well be applied to the study of any culture group.

Mesoamerican Subsistence Techniques

This essay was prepared for the Mesoamerican Cities Project, Educational Services, Inc., Harvard University, Cambridge, Mass. In September 1960, a shorter version was read and discussed in Cambridge at a meeting of the project contributors, made up of scholars of Mesoamerican culture and chaired by Dr. Gordon Willey, Department of Anthropology, Harvard University. Because of funding and editorial problems, publication of the papers prepared for the project had to be cancelled. In 1964, the original essay was revised and the accompanying bibliography updated. Some of the data presented were later published in the textbook *Middle America: Its Lands and Peoples*, by R. C. West and J. P. Augelli, chapter 8, entitled "Mexico and Central America: the Pre-Conquest Setting," Prentice Hall, 1966 and subsequent editions.

**Key words**: Mesoamerica, agricultural subsistence, crop complexes, aboriginal plant domestication.

The Geographical Base

The culture area called Mesoamerica—-one of the hearths of American Indian civilization—lies almost wholly within the tropics (fig. 1). There, temperatures vary little with latitude, but do so greatly with altitude. Thus, two fundamentally different natural areas can be distinguished in terms of temperature: (1) the tropical lowlands *(tierra caliente)* and (2) above 3,000 feet, the tropical highlands *(tierra templada, tierra fría)*. Aboriginal subsistence techniques differed greatly between these two contrasting ecological zones.

Owing chiefly to the varied geology, mountainous character, and contrasting exposures to rain-bearing winds in much of Mesoamerica, ecological diversity within both lowlands and highlands is extreme.
Fig. 1. Area of Mesoamerican civilization prior to the Spanish Conquest: central and southern Mexico, and northern Central America. Southern Central America and Cuba were occupied by simple farmers of South American origin.

Possibly it was this diversity of natural conditions within short distances that gave rise to interregional trade and cultural exchange which in turn encouraged the development of high civilization in what is now central and southern Mexico and northern Central America.

The Tropical Lowlands

In the tropical lowlands frost is absent; where rainfall is plentiful, plant growth continues throughout the year. On the rain-drenched Gulf and Caribbean side of Mesoamerica rain forest forms the dominant natural vegetation, the subhumid northern Yucatan coast with its tropical scrub cover being the major exception. On the drier Pacific side tropical deciduous forests prevail in the lowlands.

Several advanced cultures, including the Maya, Totonac, and Huastec, occupied the greater part of the lowlands on the eastern side of Mesoamerica. These lands present a variety of ecological conditions based on geology. The Yucatan limestone platform, characterized by largely subsurface drainage and thin calcareous soils, afforded peculiar subsistence problems and opportunities. On either side of the peninsula, the lowlands are formed mainly by a series of alluvial deltaic plains separated by low hills. The present-day association of large archaeological sites and river flood plains in Veracruz, Tabasco, and eastern Guatemala indicated the value that ancient farmers attached to fertile alluvial soils. In addition, the low volcanic massif, Los Tuxtlas, in southern Veracruz, is another prime agricultural area by virtue of its highly fertile soils. Throughout the eastern lowlands a short dry season of two or three months duration (February-April) characterizes the rainfall regime, in contrast to the long, six-month dry period on the Pacific Coast.

The Tropical Highlands

Two altitudinal subzones may be distinguished in the tropical highlands: the tierra templada (3000-6000 feet elevation) and the tierra fría (above 6000 feet). The latter experiences frequent killing frosts during the "winter" or cooler part of the year. In most of the Mesoamerican highlands, oak and pine forests on mountain slopes and grassy meadows on basin floors compose the natural vegetation; on the northern edge of the upland in central Mexico increasing dryness limits natural plant cover to short grasses and thorny shrubs with tall trees only along water courses. Rainfall is definitely seasonal; in central Mexico, 80 percent of the annual precipitation falls in afternoon thundershowers between mid-June and the end of September.

A number of plateaus and mountain massifs comprise the highlands, each with its distinct set of ecological characteristics. On the northern margin of the tropics lies the Mesa Central, a high plateau (6000-8500 feet elevation) composed of volcanic mountains and hills separated by extensive, flat-sided-basins. All of the basins once contained lakes, and some of them still do. The beds of the former lakes now contain fertile soils. The most renowned of the lake basins is the Valley of Mexico, which until 1900, contained five large lakes. It was around the shores of these upland water bodies that the Aztec civilization and its forerunners, including that of Teotihuacán, grew and flourished. South of the Mesa Central and separated from it by the low, hot Balsas Valley lies the Mesa del Sur of Oaxaca and Guerrero, an extremely rugged, geologically complex area with few upland basins. Of these, the Valley of Oaxaca (5000 feet elevation), became the center of Zapotec civilization. Beyond the Isthmus of Tehuantepec a high limestone plateau forms the northern Chiapas highlands and extends into north-central Guatemala. Farther south are the volcanic highlands of southern Guatemala, a part of the great volcanic axis that extends along the Pacific side of Central America into Panama.
Both the limestone and volcanic uplands of Guatemala and Chiapas formed the home of highland Maya culture. The volcanic area contains many of the features described for central Mexico, including lake-filled basins and fertile soils derived from the weathering of recent ejecta.

Within the physical landscapes outlined above, Mesoamerican Indians developed their civilization upon an agricultural subsistence base. It is the purpose of this paper to sketch some of the salient aspects of food crops and cultivation techniques perfected by the Mesoamericans in pre-Columbian times, as background for the presentations of urban developments in ancient Mexico and Central America.

The Crop Complex

Within Mesoamerica is found one of the major centers of aboriginal plant domestication in the New World. This center lies chiefly in the highlands and adjacent lowlands of southern Mexico and northern Central America, precisely within the area where high Indian civilization developed. At the time of the Spanish Conquest, the Indians of Mesoamerica were cultivating nearly 90 different species of plants, about 70 of these being native to the area, the remainder imports from South America. These domesticates included starchy and protein-rich seed plants, such as maize and beans; vegetables of many kinds; fiber- and dye-yielding plants; condiments, mainly chile; ornamental and ceremonial flowers, such as dahlias and marigold; and a large variety of fruits, the latter comprising nearly half of the total number of plants cultivated. There was probably no other area in the world of the late 15th century that could boast of such an extraordinarily rich assemblage of domesticated plants.

Of these, the basic food crops in Mesoamerica were maize, beans, and squash, still the staff of life for millions of Mexicans and Central Americans. The three plants can be cultivated in both highland and lowland environments and are ideally suited to the wet-and-dry rainfall regime of Mesoamerica. This plant triad affords a fairly well-balanced diet. Maize furnishes the starch or carbohydrate element, and is also rich in oil; beans give the protein component, largely taking the place of meat; and squash offers a variety of essential vitamins in its oil-rich seeds (roasted) and in its flowers and flesh (cooked as vegetables). In ancient times, Indians cultivated all three crops together in the same plot, as many still do today. Through centuries of cultivation, something of a symbiotic relationship has developed between these three plants. The tall maize stalks serve as supports for the climbing bean vines, which in turn enrich the soil with nitrogen. The squash plants being creepers, cover the ground beneath the maize and beans with their wide leaves, protecting the loose soil from undue erosion by the heavy afternoon downpours characteristic of the rainy season and loss of moisture from rapid evaporation.

The Indian farmers of Mesoamerica prepared maize foods by soaking the hard kernels in lime water just as their pure and mixed-blood descendants do today. This process softens the grains and aids in separating the tough skin that covers each kernel, so that the maize can be ground on the stone quern, or metate, to prepare a heavy dough called nixtamal. The soaking process also adds a significant amount of calcium to the dough, thereby contributing a nutritive element essential for human health. From the nixtamal or maize dough; at least three important foods are prepared:

1) The tortilla was the most common food—a thin, round "pancake" of dough baked on a comal, or large clay plate.
2) Tamales were made of maize dough with a meat, fish, bean, or chile-pepper filling, wrapped in corn husks, and heated in water.
3) Atole, perhaps the most ancient of the maize foods, was a thick, starchy gruel of boiled maize dough flavored with chile pepper or various fruits, and drunk from a clay bowl.

Other maize foods included pozole, a thick soup of hominy (whole cooked kernels of corn) with vegetables and highly seasoned with chile. In the Mayan area of southern Mexico, the name pozole referred to a watery gruel of dry-ground corn meal flavored with chocolate. Pinole was made by grinding toasted maize kernels to a coarse meal, often flavored with honey.Small, immature maize ears (elotes) were boiled as vegetables and ears of fresh corn (elotes) were eaten parched or boiled, just as they are today.

Chile pepper is another important food crop common to both highland and lowland Mesoamerica and was present throughout the area of aboriginal farming in the American tropics. This highly piquant condiment functions nutritionally as an abundant source of vitamin A (carotene) and vitamin C (ascorbic acid) in the maize-beans-squash that is otherwise deficient in these substances; the condiment also served as a gastrin, or digestive stimulant, in a diet dominated by bland, starchy maize foods.

In the Mesoamerican highlands, several cultivated food plants, well suited to high altitudes and dry conditions, supplemented the maize-beans-squash complex. Among these was grain amaranth (huautli), which at the time of the Spanish conquest appears to have been as important as maize in terms of amount harvested and consumed within the Aztec tribute state. Many cultivated species of agave (the century plant) furnished both food and fiber. The basal portions of its fleshy leaves were pit-cooked to make the sweet, starchy mescal; possibly one of the most ancient prepared plant foods in Middle America. Moreover, the Aztecs and their neighbors fermented the sweetish sap of some agaves to make...
the famous drink called pulque or octli, rich in ascorbic acid (vitamin C) and thiamine (vitamin B₁). For the Mesoamerican highlanders as well as the Maya of northern Yucatan, the strong fiber extracted from the fleshy agave leaves sewed for making rope and sandals, and among the former it was the chief local source of fiber (ixtli) for weaving cloth.

Pre-Spanish cultivation in the tropical lowlands of Mesoamerica was distinguished by the large number of domesticated fruits, most of which are high in ascorbic acid. Among these were pineapple, papaya, many kinds of sapotes, the hog plum (jocote), several varieties of sour sop (guanabana, chirimaya), avocado, and cacao. Cacao, the source of chocolate, assumed great importance in aboriginal interregional trade, for the beans were easily transported and so highly valued that they became a medium of exchange within Mesoamerica. The consumption of chocolate drink, however, was largely confined to nobility in ancient times. Other plant domesticates included cotton for fiber and various dye plants, such as ahuite and indigo. In addition, the cultivation of various starchy tubers of South American origin, such as yuca, or sweet manioc, and the sweet potato, by the late 15th century had penetrated into the southern part of Mesoamerica, where they were cultivated by the Maya and their neighbors.

Animal Domesticates

In contrast to their wealth of agricultural plants, the Indians of Mesoamerica had only three truly domesticated animals. These were the dog, one variety of which was the short-legged, hairless edible type; the turkey, domesticated probably in southern Mexico; and the small stingless bee, kept for its honey and wax. As sources of food, these few animals were definitely secondary to the cultivated plants, though honey was the main sweetening ingredient in Mesoamerican diet.

Hunting and Fishing

The Mesoamerican Indian supplemented his predominately vegetable diet by exploiting wild animals within his environs. It was particularly in the environment of highland lakes within the volcanic areas of Central Mexico that these activities became well developed among the farming population. Shallow lakes usually afford a great variety of food for man, the edible animal life ranging from fish and aquatic birds to insects, including their eggs and larvae.

Fishing was an important occupation for many Indians living around the lakes of the Mesa Central, especially in the Valley of Mexico and in the lake-studded Tarascan country of Michoacán. Most of the lacustrine fish resource was composed of small, sardine-like varieties caught by the thousands in nets and dried for later consumption. Bernal Díaz, in his description of the great market of Tenochtitlan tells of the large amounts of dried and fresh fish caught in Lake Texcoco. Rich in protein, calcium, iron, and many essential vitamins, this abundant fish resource furnished an important supplementary element in the diet of the ancient highland Mexicans.

In the lacustrine environments of central Mexico, the hunting of aquatic fowl was probably as significant as fishing. Every year large flocks of migratory water fowl (mainly ducks and coots) from North America wintered in the reed-clogged lake shores in the Valley of Mexico and adjacent basins. For fishing, the Indians employed long nets attached to stakes and also used forked spear throwers, or atlatl, one of man's most ancient weapons, still used today by a few Tarascan fishers on Lake Pátzcuaro.

Probably equally important as food were the various insects, crustaceans, reptiles, and rodents hunted and gathered within the shallow, marshy sections of the lakes. Frogs, tadpoles, turtles, crayfish, and a larval salamander, which the Aztecs called axoxotl, were netted and gigged in large numbers. Of especial esteem in the Valley of Mexico were the eggs of various waterbugs which the Indians gathered from reeds growing along the lake shores. These eggs formed the famous ahuaahiti, or "Aztec caviar." Moreover, the larvae of a salt fly as well as green algae were skimmed from the lake surface for food. Although such things are not considered proper food in our own Western culture, they are rich in protein and several minerals and vitamins essential in the human diet. These seemingly weird foods helped to supply dietary deficiencies that might have occurred among a population dependent mainly on maize, beans and squash. Again, during times of crop failure, which due to droughts, hail and untimely frosts were not infrequent on the central plateau, the lake resources served as famine food.

The Maya and their neighbors living in the hot, humid lowlands, lacked the favorable lacustrine environment enjoyed by the people of central Mexico. However, the abundance of large wild animals, such as the peccary and, especially, the white-tailed deer in the forests and tropical scrub of southeastern Mexico encouraged hunting. In addition, coastal dwellers caught marine shell-and fin-fish along the Caribbean and Gulf shores, but such food must be considered as being minor in the total diet of the farming population.
Gathering of **Wild Plants**

Like hunting and fishing, the exploitation of wild plants was quite secondary in the dominantly agricultural economy of the Mesoamerican Indians. Yet a few small plants which women gathered as potherbs around settlements and in abandoned fields proved to be significant in the aboriginal diet. Such potherbs included the group called "pigweeds," that grow in disturbed places within both highland and lowland tropical environments. Wild amaranths and Chenopods (goosefoot) compose most of these. Other weeds gathered as potherbs include chipilin (Crotalaria, spp.) and various malvaceous plants, and furnish essential elements in the Indian diet, much as they do today in rural districts of Mexico and Central America.

**Systems of Fanning**

To cultivate their many domesticated plants in Mesoamerica, Indians developed various methods of farming according to natural conditions and technical knowledge. These methods varied from simple, migratory slash-burn (swidden; bush fallow) farming within forested lands to highly developed and intensive tillage of permanent fields found mainly in highland areas. Food production per unit area increased as greater intensity of cultivation resulted from technological advances in farming. In turn, population densities increased with greater food production. **Therefore,** it is here postulated that truly urban forms of settlement arose in those areas of Mesoamerica where advanced types of tillage were developed and practiced.

At least two general systems of farming prevailed in Mesoamerica in pre-Spanish times; (1) migratory slash-burn cultivation and (2) advanced farming, which involved (a) systematic fallowing of permanent fields and, occasionally, (b) the use of various modes of terracing and/or irrigation.

Several features were common to the two farming systems. For instance, individual fields were small, probably no more than one to six acres in size. Moreover, the Indian farmer practiced horticulture rather than single-crop field agriculture characteristic of Western culture and now common in most of Latin America. The Indian gave special care to individual plants, cultivating a great variety within his small plot; not only were maize, beans and squash raised together, but a few tomato, chile, or amaranth plants and perhaps one or two fruit trees were also scattered about until his holding took on an unordered, unkempt appearance. Again, the same types of farming instruments were employed in both systems of cultivation. These were (1) the simple planting stick, or dibble, with a sharpened, fire-hardened point and (2) in some sections of central and eastern Mexico, the **coa,** a kind of spade with a triangular-shaped blade paralleled with the handle. In the **Tarascan areas**, coas with copper blades were used, but elsewhere they probably were wooden.

Still another feature common to both tillage systems was the house garden, a special plot adjacent to the individual dwelling, where women cultivated special food crops such as chiles and fruit trees or medicinal plants in soil enriched by human refuse. In Nahua-speaking areas such plots were termed **calmil,** in contradistinction to the **milpa,** or regular fields where men tended the maize-associated crops.

**Migratory Slash-Burn Cultivation**

This was the simplest and most widespread system of farming among the American Indian farmers. In the tropical lowlands of Mesoamerica it was, with some exceptions, the only type practiced, and was the basis of food production for the Mayan civilization. It was also practiced in the highlands, particularly on steep, wooded slopes.

Today, as in ancient times, the system involves the clearing of small plots within the forest during the dry season and the burning of the dried branches and logs (fig.2). Rich in various soluble minerals, such as potassium, calcium and phosphorus, the wood ash serves as fertilizer for crops. At the start of the rains, seeds and tubers are planted in holes punched into the ash-covered soil with the dibble. Crop yields are good the first year, but usually after two or three years of consecutive harvests the topsoil is often exhausted and weeds become such a problem that the plot is abandoned for perhaps eight to 20 years to permit the rejuvenation of the soil and the re-establishment of second-growth forest. After that time, when the decaying leaves and roots of the forest plants and microorganisms have renewed soil fertility, and when shade has reduced the sun-loving weed species, the same plot may be recleared and the cycle repeated. Meanwhile in the surrounding forest, the farmer has cleared new plots which Likewise go through the same cycle of cropping and abandonment. In **central Mexico** today, subsistence farmers call such slash-burn plots by the Nahua terms **tlacolol** or **coa mil,** in the lowlands of Yucatán they are sometimes known by the Maya word, **cel.**

It is readily apparent that, owing to the frequent shifting of cultivated plots, a large forested area is needed for the continued operation of the slash-burn system. Being an extensive type of cultivation, it can normally support only a low to moderate density of population, depending on natural (especially soil) conditions. With this simple farming technique at their disposal the lowland Maya were able to produce sufficient food to support a highly advanced culture, though production may not have been sufficient to support large clusters of urban population. More-
over, the extensive and migratory nature of the system often leads to dispersed population patterns, the farmers living in scattered hamlets rather than in compact villages.

Despite an extensive type of cultivation, the lowland Maya were able to produce surplus food chiefly because of favorable ecological conditions within their rain-forest environment. Derived from the weathering of soft limestone, the soils of the Yucatán Peninsula are inherently more fertile for crop growth than the usual mature red-and-yellow clays of most lowland tropical areas. Early Spanish chroniclers commented on the fertility of the thin red soils (terra rossa) of northern Yucatán, and it may be significant that many classical Mayan sites in the Petén coincide with reasonably fertile red to grey rendzina soils. Both terra rossa and rendzina are high in calcium derived from the limestone parent material, despite heavy leaching. It is also significant that many large classical Mayan ceremonial centers were built upon or near the natural levees of river flow-plains, as within the Usumacinta drainage or the Lower Motagua River. In cultivating the fertile alluvium of these areas with the slash-burn system probably weed competition than soil exhaustion induced declining yields and periodic abandonment of fields. Recent studies on ecology and agricultural processes suggest a potential population density of 30 to 60 persons per square mile within the Maya lowlands in ancient times.

Double cropping (two annual harvests) in the same plot constitutes an important variant of slash-burn cultivation. Today subsistence farmers practice double cropping chiefly in the Veracruz and Tabasco lowlands, where "winter" rains caused by nortes, or incursions of cold air masses from the United States, prolong the wet period into January and February. The first and principal maize crop, called temporal, is planted in June or July at the start of summer rains. After December harvest, the field is planted to the second crop, or tonamil, harvested in May of the following year. Although the tonamil harvest is only two-thirds that of the temporal in quantity, double cropping does increase food production over the normal one-crop slash-burn system. As double cropping is deeply ingrained in the present-day cultivation techniques of the Huastec and Totonac of Veracruz and the Chontal of Tabasco, it is probable that the system is ancient and may have been practiced by the Maya in pre-Spanish times in those areas of the Yucatán Peninsula that receive winter rains. In the Petén rain forest of northern Guatemala, four maize crops are often harvested at different times of the year, but not from the same fields.

In most areas of the tropical world slash-burn farming appears to operate well when population density remains stable. Once rapid population increase occurs, for whatever reason, the system tends to break down, because fallow periods are decreased in length, the forest fails to regenerate properly, on slopes erosion ensues, and often grass invades. This sequence of events has long been used as an attractive explanation for the decline of classical Maya culture in the rain forest-covered Petén; however, results of recent ecological investigations in the area appear to negate an ecological cause for the Mayan demise.

In the highlands of Mesoamerica, the temperate forests do not quickly regenerate after cutting or firing; thus slash-burn farming was used to clear land that was later worked with more advanced systems of cultivation. In highland environments of Mexico and Guatemala today, slash-burn is practiced chiefly on steep slopes that retain forest remnants; probably the destruction of much of the oak and pine forest that once covered portions of central Mexico and Oaxaca has been due partly to the overuse of slash-burn cultivation in pre-Spanish and colonial times.
Advanced Systems of Tillage

In contrast to migratory slash-burn cultivation, advanced farming in Mesoamerica was characterized by permanent fields and occasional utilization of sophisticated techniques such as terracing, irrigation, and application of fertilizer. Generally, such practices may have resulted in larger food surpluses, greater population densities, and a more agglomerated settlement pattern than was possible under the simple migratory cultivation system. On the other hand, some investigators maintain that intensive farming methods may have been developed as a result of increasing population. In any case, advanced farming techniques were developed and utilized chiefly in the highlands rather than in the tropical lowlands.

Fallowing of Permanent Fields

Although somewhat akin to slash-burn farming and probably derived from it, the fallowing of permanent fields in the Mesoamerican highlands was more productive of foodstuffs in terms of total land area cultivated. This method began by clearing and burning of the vegetation cover, but two or three years of successive cropping was followed by an equal period of fallow. The farmer thus confined his attention to a few more or less permanent fields within a small radius, a system conducive to permanent village settlement and fairly dense population (fig. 3). Indians practiced fallowing generally in the cool highlands, particularly around the fertile volcanic basins of central Mexico and southwestern Guatemala and in the central valley of Oaxaca. They kept mainly to the lower, gentle slopes surrounding the basins; it is doubtful that with only the simple dibble or even the wooden or metal-bladed coa as a tool they would have been able to till the flatter basin floors characterized by heavy soils and thick grass cover. The fertile lacustrine soils of most of the highland basins were probably little utilized for agriculture until the Spaniard introduced the plow and draft animals in the 16th century.

Today in the Mesoamerican highlands, most crops cultivated by the fallow system depend upon summer rains for moisture (temporal crops). However, certain areas favored by moisture retentive soils or by a high water table are sufficiently moist to produce early crops and occasionally two harvests annually. Such areas are called de humedad and likely were as significant to Mexican farmers in pre-Conquest times as they are today. In northern Yucatán, the lowland Maya utilized solution hollows (hojas) filled with deep, moist soil for cultivating maize, and partially dry sink holes (cenotes) for cacao gardens; both features may be classified under humedad farming.
Before 1500 AD, the construction of retention walls and level cultivation surfaces on slopes, was widespread in the Old World, but in the New World was highly developed only in the Central Andes of South America. Generally, this agricultural technique among the Mesoamerican highlanders was rudimentary; these stone-faced terraces vaguely similar to those of the Andes seem to have been constructed only by the Aztecs on the eastern side of the Valley of Mexico.

A common type of incipient terracing seen today especially on the Mesa Central of Mexico consists of elongated, gently inclined fields paralleling the contours of moderate slopes along the base of hills and mountains. The downslope side of each of these terrace-like plots is lined with a row of agave plants (maguey), creating a low stepped embankment (fig. 4). Such fields are variously called pantli (meliapantli), melgas, or bancales. They are best represented on the southern side of the Valley of Mexico, around Milpa Alta, where the pantli fields produce a landscape of serried rows across the entire slope; areas of similar fields are scattered from the Toluca Basin eastward to the edge of the plateau in Veracruz and Puebla and farther south they occur sporadically around the rim of the Valley of Oaxaca. The width of individual plots varies from five or six meters on gentle slopes to less than a meter on steeper ones, the surface incline being somewhat less than the original hill slope; field lengths vary from a few meters to more than 100. Apparently the function of the pantli field is to prevent undue erosion and to accumulate moisture in the thin soils on hillsides, the rows of agave serving as check dams. That this device was employed in pre-Spanish times is evidenced by the presence of Aztec-type potsherds and obsidian flakes and cores in both abandoned and occupied fields.

A second type of present-day incipient terracing in Mesoamerica occurs in the form of low stone check dams constructed in beds of shallow water courses (fig. 5). Such dams (or weirs) pond occasional stream flow and catch sediment which eventually builds up a level planting surface of fertile, moisture-retentive alluvium. In and around the Valley of Mexico these stone dams are called tecercas or presas; they also occur in arroyo channels in Oaxaca and Chiapas. Further research is needed to ascertain the antiquity of this agricultural device in Mexico; preliminary investigation indicates that it may be quite ancient.

Still, a third kind of crude terracing found in Mesoamerica consists of small, irregularly-shaped, dry-wall stone embankments. In some cases they form contiguous steps covering entire slopes, but more often they are isolated, scattered at random over hillsides. These terraces extend disjointly from Hidalgo state on the Mesa Central southward through Oaxaca, Chiapas, Guatemala, as far as the Maya Mountains in British
Honduras. In the Chiapas highlands and in British Honduras, they are completely abandoned; their mined condition suggests great antiquity. Those in British Honduras are covered by rain forest, and are brought to light by occasional slash-burn fields or logging operations. Some of those around the Valley of Mexico, where they are called tecuemetl (constructed on steep edges of lava flows), are still cultivated, but most have been abandoned since the agrarian reforms of this century (fig. 6). Various investigators have suggested that such terraces were constructed to control soil erosion and to accumulate alluvial fill in areas where overuse of slash-burn cultivation had destroyed the forest cover and where density of population had increased beyond the capacity of this extensive-type farming.
The most sophisticated mode of terracing that Mesoamerican Indians are known to have developed is exemplified by the stone-or adobe-faced, linear contour, irrigable terraces seen today on the eastern side of the Valley of Mexico (above the town of Texcoco) within the ancient Acolhua Domain (fig. 7). The form of these terraces suggest construction by earth fill behind a strong dry wall embankment, creating a narrow, nearly level cultivation surface. Associated features include irrigation canals which divert water from nearby springs onto the terraces. Although many of these are still cultivated, investigators believe that much of the terraced and irrigated area within the Acolhua Domain utilized during the 15th century was abandoned soon after the Spanish invasion.

The development of terracing in Mesoamerica prior to the Spanish conquest may have been the result of population increase and a growing scarcity of farm land, necessitating an enlargement of agricultural output or the attempt to regain agricultural productivity in areas suffering from soil erosion.

Ridge Farming in Guatemala

In the southwestern highlands (Los Altos) of Guatemala an interesting type of ridge cultivation is today practiced on both flattish and sloping terrain. The system involves the heaping of earth (using wide European-type hoes) into wide elongated ridges (called tablones), most of which follow the contour, forming a system of earthen terraces (fig. 8). The loose, friable volcanic soil conserves moisture and makes an ideal planting surface, yielding greater harvests than those obtained from plowed fields in adjacent ladino (mestizo) areas. That the tablón system is pre-Spanish is uncertain; today it is so deeply entrenched in the highland Indian culture of southwestern Guatemala that European plow cultivation has been rejected.

Irrigation

The artificial watering of fields to insure crop yields in areas of rainfall deficiency or marked unreliability, constituted one of the most advanced forms of cultivation within Mesoamerica. With irrigation, where temperatures permitted, two or more crops annually could be harvested from the same field, producing more food that could be raised either by dry-farm fallowing or by slash-burn. Irrigation also permitted the cultivation of crops with special moisture requirements, such as cotton and cacao, in sub-humid lowland river basins in south-central Mexico.

Some forms of irrigation may have developed exceptionally early in Mesoamerica; evidence derived from recent archaeological investigations...
The most fascinating kind of irrigation technique that Mesoamericans developed was the chinampa system, sometimes erroneously called “floating garden” agriculture (see the chapter on Chinampas in this volume). This ingenious system represents one of the most sophisticated and productive kinds of farming practiced by the American Indian, and may have been one of the most intensive types of cultivation in the ancient world. Although natural conditions favorable for their construction are found in many parts of the Mesa Central, curiously, chinampas were developed mainly in the Valley of Mexico, where archaeological evidence indicates that the technique may be of some antiquity.

Chinampas were artificial plots constructed along the shallow margins of fresh-water lakes or marshes. Ordinarily plots were elongate, two to four meters wide, often more than thirty meters long, and were separated by narrow canals (fig. 9). They may have been constructed in either of two ways: 1) excavation of canals in mud of shallow lake bottoms or marshes and piling of the organic-rich material to form the long fields or 2) piling of long strips of aquatic vegetation cut from thick masses of lake flotant one atop the other until the strips sank to the lake bottom and the top one extended above the water surface; subsequently, rich mud scooped from the lake or marsh bottom was spread over the chinampa to form a planting surface. The first method may have been used to construct the chinampas in wet areas near Teotihuacán, northeastern part of the Valley of Mexico, where the elongated, canal-divided fields are cultivated still today. The second and more common method is described for the construction of the chinampas that today extend from Xochihilco eastward to Mizquic along the southern edge of the Valley To anchor the plots securely and to prevent erosion, native willows were planted along the edges. Such trees give the present chinampa areas their pleasant sylvan appearance.

From three to four annual harvests of maize, beans, chile, flowers and other plants could be obtained from a given chinampa, for the crop was started in seed beds and transplanted to the chinampa surface. Continuous natural irrigation was effected by seepage from the canals...
through the porous soil, or hand irrigation was practiced by applying water from the canals onto the narrow planting surface with long-handled wooden scoops. Young plants were protected from winter frosts with mats of grass. Fertilizer in the form of lake mud, rotted vegetable matter, and for some plants, bat dung was applied before each planting.

There is little doubt that the dense rural population and the presence of large cities in the Valley of Mexico in pre-Spanish times were based mainly on the tremendous amount of food produced in these intensively cultivated plots. When Cortez and his party arrived in the Valley of Mexico in 1519, the chinampa area covered the shallow margins of the southern fresh-water lakes of Chalco and Xochimilco and extended northward along the western edge of Lake Texcoco beyond Tenochtitlán to Azcapotzalco. To prevent periodic incursion of saline water from Lake Texcoco into the chinampa area and to regulate lake levels, an elaborate system of dikes was constructed. Each of the causeways that connected the Aztec capital with the mainland served both as road and dike. Located east of the capital, the largest dike was that of Nezahualcoyotl, which effectively protected Tenochtitlán and the western margin of Lake Texcom from saline water.

**Fig. 9. Old chinampas near town of Ixtapalapa, Valley of Mexico. Photo taken in 1947.**

In pre-Columbian times Mesoamerican Indian farmers had at their disposal one of the most varied and nutritious assemblages of food crops in the ancient world. Although the lowlanders used chiefly the extensive and rudimentary slash-burn type of cultivation, food production seems to have been sufficiently high to have supported a relatively large but dispersed population. It was in the highlands, however, that advanced farming techniques were best developed and most utilized. With intensive cultivation highlanders produced enough food to support a quite dense agglomerated rural population as well as large urban centers. Within the highlands, the lacustrine Valley of Mexico appears to have been the focus of urban life; it was likewise the most significant center of terracing, hydraulic engineering (including various types of irrigation), and food production in Mesoamerica.

**Conclusion**

1. The beginnings of the cultivation of food plants in Mesoamerica date back to at least 5000 B.C.

2. The Aztecs attached a considerable ritual significance to amaranth which may attest to its antiquity. Ceremonial foods in forms of human effigies were made of the tiny amaranth seeds mixed with human blood and presented to the war god, Huiztilizopochtli, in the appropriate temples. Today, only small plots of amaranth are cultivated in isolated localities of Mexico and Guatemala. Curiously, the small village of Tulyehualco, a few miles south of Mexico City, specializes in the cultivation of this tiny seed for making small cakes that formerly were eaten only during Holy Week and at Christmas, but are now sold by street vendors throughout the year.

3. Not to be confused with the distilled intoxicant of the same name, made also of agave, but not until after the Spanish had introduced the process of distillation in the 16th century.

4. It should be emphasized that during the Aztec hegemony, authorities strictly limited the use of pulque to warriors, pregnant women, and old people, despite its high food value. It appears that only after the Spanish conquest did the use of pulque become general among the Indians of Mexico. Today it is considered the "poor man's drink," and is gradually being replaced by the European-type beer.

5. Two small scale insects were semidomesticated. One was the cochineal bug, which feeds on a variety of nopal, or prickly-pear cactus, and was raised for a scarlet dye (cochineal). Another scale bug, called nje or njin, was cultured on certain trees for its wax, used as a base for lacquer and for burning pottery.

6. Still today in the remaining lakes outside the Valley of Mexico, the small pescado blanco, or charales are caught, dried, and sold in some markets. In the large New Year's markets at Tlaxcala, even the ancient fish tamales (masilapitques) are still made and sold.

**Endnotes**

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7. Some investigators hold that simple farming techniques, such as slash-burn, can yield as much or even more food—in terms of amount of labor invested—as more advanced practices; consequently, in terms of food potential, urban centers could develop among peoples having only simple farming systems as readily as among those with highly developed techniques. This reasoning has led some to the conclusion that the key factor in the origin and growth of cities is not the ecological situation, but the existence of a particular kind of social organization amenable to the development of urban life. The next question, of course, is whether social organization may not be at least a partial product of particular ecological conditions.

8. Slash-burn cultivation is often mis-termed "milpa" system of agriculture. In Mexico and Central America, the Nahualt word "milpa" is applied to any field where maize is cultivated, regardless of the system of farming used.

Bibliography


