CHAPTER

6

Early Agriculture in Chihuahua, Mexico

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Glossary

Altithermal Proposed middle Holocene hot and dry period for the western United States.

Cerros de trincheras sites Hilltop sites with terraces, walls, and other stone features.

Fluvial terraces Landforms resulting from riverine deposition and erosion.

Proto-Uto-Aztecan language Hypothetical language ancestral to modern Uto-Aztecan languages.

Tarahumara Indigenous people of southern Chihuahua, Mexico.

Northwestern Mexico is critical for understanding the spread and adoption of farming as it lies between Mesoamerica, where maize farming began, and the American Southwest where maize had a tremendous impact on local societies. Recent research in the state of Chihuahua reveals new information regarding the ecological and cultural contexts of the spread and adoption of maize farming. Substantial levels of farming were underway in northwestern Chihuahua by ca. 1300 BC, and maize was present by 200 BC in the Sierra Madre Occidental of southwestern Chihuahua, and tentatively by 1700 BC in south-central Chihuahua. The pace at which maize was integrated into local economies across the American Southwest and northwestern Mexico in the millennia following its initial introduction around 2000 BC is generally gradual but was more rapid in some locales including northwestern Chihuahua and southern Arizona.

INTRODUCTION

Understanding the spread of maize agriculture from Mesoamerica to northern Mexico and the American Southwest is fundamental to addressing a series of theoretical issues related to the impetus and consequences of the adoption of farming in this region and around the world. Here, we review recent research on the earliest maize in the northern Mexican state of Chihuahua and assess its relevance to current issues including the timing, spread, adoption, and consequences of agriculture.

EARLY AGRICULTURE

Chihuahua sits between Mesoamerica where maize agriculture originated and the American Southwest where agriculture had a profound impact on most local societies. Compared with Chihuahua, both of these areas are well known archaeologically and provide frameworks for considering the processes involved in the arrival and adoption of maize agriculture in northern Mexico.

Histories of Maize in Mesoamerica

Multidisciplinary Approaches

John E. Staller | Robert H. Tykot | Bruce F. Benz

Despite the lively debate about the details of the timing, geography, and biology of early agriculture in Mesoamerica, researchers agree that the major cultigens—maize, beans, and squash—originated in tropical Mesoamerica and then spread to other parts of the New World [10, 33, 68, 69, 70, 90, 96]. The Guilá Naquitz site in Oaxaca has yielded maize dating to 4300 CAL BC, the earliest directly dated maize encountered thus far, but molecular evidence suggests that maize was first domesticated somewhat earlier along the Río Balsas of Michoacán and Guerrero [112, p. 2102]. An earlier initial domestication of maize in Mesoamerica also is suggested by rapidly accumulating, yet still controversial, pollen and phytolith evidence, which raises the possibility that maize arrived in Central and South America between 5500 and 3000 BC [111, 116, p. 1371; 134]. By about 3500 CAL BC, maize had spread northeastward to Puebla's Tehuacán Valley, and it was present in the northern Mexican state of Tamaulipas by 2400 CAL BC [80, p. 1039; 84, 130, 131, p. 1326]. Between ca. 1500 and 1000 BC maize farming populations occupied permanent villages across much of southern tropical Mexico and temperate western Mexico and complex societies were present in some locales by ca. 1000 BC [16, 17, 37, 42, 55, 91, 104, 113, 114, 132].

In the American Southwest, the Early Agricultural Period is defined as the interval before the widespread use of ceramic technology during which domesticated plants were introduced and became widely accepted, although its span flexes as new data accumulate (Table 6-1) [64, 65]. The Early Agricultural Period cross-cuts the traditional Middle and Late Archaic Periods, which are used in this chapter as purely temporal units without regard to the presence or absence of agriculture. The date for the initial arrival of maize on the Colorado Plateau is now firmly placed at about 2100 CAL BC with a cluster 10 accelerated mass spectrometry (AMS) maize dates [62]. These results confirm previous reports that maize is in multiple locations by 2000 BC [43, p. 118; 44, pp. 253; 66, 147]. By 1600 CAL BC, maize is widespread in the region, and by AD 100 it is nearly ubiquitous [49, pp. 1661; 83, 147]. The ending date of the Early Agricultural Period should perhaps be when ceramic vessel technology is well integrated into the economy rather than simply "pre-ceramic" as some ceramic objects are now known to be present during the Early Agricultural Period [81, p. 786]. A number of ceramic objects including figurines, beads, and sherds of small fired ceramic vessels have been found in a several Tucson Basin sites dating as early as 2100 BC.

Two fundamental processes characterize the Early Agricultural Period: 1) the introduction of agriculture and 2) the formation of an agricultural economy. The introduction of agriculture by any means defines the time when people first have access to domesticated grains, such as maize, and some information regarding how to produce a harvest. In an extensive review of published schemes for partitioning these processes, Bruce D. Smith [132, Figure 7] delineates three adaptive patterns: 1) low level food production without domesticates, 2) low level food production with domesticates, and 3) agriculture. The agriculture pattern includes both primary dependence on domesticates as well as subsistence strategies where domesticated plants comprise 30–50% of the diet.

Here we employ Smith's [132] scheme, using the term "agricultural economy" as a synonym for his term "agriculture" to designate the state in which hunter–gatherer adaptations have shifted in settlement, seasonal movement, social organization, and material culture to accommodate farming. Over much, but not all, of the American Southwest, the Early Agricultural Period appears to have involved low level food production with domesticates, as there is little evidence of major, agriculture-driven changes in settlement or population. Farming seems to have contributed a relatively minor portion of the diet, but may have been important in reducing risks or enhancing access to nondomesticated resources [31, 56, p. 118; 102, 148, 150]. The availability of maize did not necessarily mean, however, that all groups accepted it at the same pace or to the same extent [36, 47, 101]. For decades the standard assumption for the American Southwest was that low level food production with domesticates continued for several thousand years before the formation of agricultural settlements, and furthermore that such settlements did not appear until the middle of the first millennium AD [30, 56, 129]. A series of remarkable discoveries in southern Arizona, northwestern Chihuahua, and northwestern Sonora now challenge this traditional model.

TABLE 6-1 Time Periods

Temporal unit	Age	Notes	Refs
Early Agricultural Period	2100 BC–AD 200	Earliest evidence of maize to widespread use of ceramics; cross-cuts Middle and Late Archaic Periods	62, 64, p. 16
Middle Archaic Period	3500 BC–1500 BC	1200 or 1500 BC is frequently used	65
Late Archaic Period	1500 BC–AD 200		64, 65
San Pedro Phase	1500 BC–800 BC	1200 or 1500 BC	64

Doubts about this model were first raised by Bruce B. Huckell's [63, 65] work in southeastern Arizona, and then by other excavations of large, Late Archaic Period (Table 33-1) sites the Tucson Basin consisting of numerous pithouses and storage features that were associated with the emergence of elaborate material culture, irrigation, and limited use of ceramics [43, 45, 81–83]. These settlements are thought to be reoccupied settlements with occupations consisting of no more than perhaps about 30 persons with increasing sedentism later in time, although debate around these issues is ongoing [45, 81, 127]. Irrigation agriculture may have also have been underway by 1000 BC in the Zuni area of western New Mexico, although the cultural context of this adaptation is unknown [28].

At the multicomponent site of La Playa in northwestern Sonora maize is common along with wild plants in Early Agricultural Period roasting pits and 160 excavated human remains are associated with that period, representing 83% of the total excavated burial population [24, pp. 15–16, 103]. Preliminary analyses indicate that dental caries occurred at rate similar to that found among the Early Agricultural Period Tucson populations. La Playa occupants were also involved in a significant levels of farming and as well as foraging economy similar to those in southern Arizona [24, pp. 14–17, 103]. Some Basketmaker II occupations on the Colorado Plateau were substantially dependent on maize by ca. 100 BC [47, 93, 95]. In northwestern Chihuahua we have investigated Cerro Juanaqueña and a series of related **cerros de trincheras sites** (hills with constructed terraces and walls) whose occupants relied on farming for a significant part of their economy from 1350–1300 CAL BC until about 1100 CAL BC [1, 50, 51, 120]. We will discuss our findings in more detail in this chapter.

In sum, it now appears that in various locales approximately 1000 years of low level food production with domesticates, from ca. 2000 BC to ca. 1300–1000 BC, precedes a level of farming that can be considered an agricultural economy in a few locations. However, over most of the American Southwest, low level food production with domesticates persisted for 2000–2500 years. In these areas the standard model still appears to be applicable with settled, farming communities arising only after about AD 100–500 [47, 126, 149]. In some regions, such as the southern Jornada Mogollon near El Paso, Texas, this transition does not occur until after AD 900, reflecting more than 3000 years of low level food production with maize present in that region beginning in the Late Archaic Period [47, 145].

THE INTRODUCTION OF MAIZE

Since the 1940s, most scholars have believed that it took a period of several thousand years for successive groups of hunter–gatherers to spread maize northward from central Mexico to the American Southwest. Several routes of diffusion have been proposed: the uplands of the Sierra Madre Occidental, the north–south trending river valleys of Chihuahua, Arizona, and New Mexico, and the Sonoran coastal plain [6, p. 249, 56, p. 113, 65]. However, the early and widespread occurrence of maize in the American Southwest, northwestern Mexico, and northeastern Mexico suggests that maize may have diffused along one or more broad fronts [9].

Migrations northward by groups of farmers is usually cast as an alternative explanation to group-to-group diffusion of maize. Most migration theorists suggest that local people quickly adopted the newcomers' maize. Claudia F. Berry and Michael S. Berry [11] initiated recent debates by proposing that the San Pedro Phase in the southern Southwest began around 1200 BC with the arrival of farmers from Mexico [64]. This phase spans about 1200–800 BC and is recognized on both sides of the international border [135]. Matson [93, 94] also suggests the San Pedro Phase and other, related cultures represent migrants from Mexico, whose descendants included Western Basketmaker II occupants on the Colorado Plateau.

Jane H. Hill [58–61] attributes both the original domestication of maize and its spread from central Mexico into the northern American Southwest to growing populations of **Proto-Uto-Aztecan** farmers who expanded northward, out competing local hunters and gatherers. In large part she bases her view on reconstructed agricultural terms that she proposes formed part of Proto-Uto-Aztecan and similar language–agricultural dispersal models from Europe and other parts of the world [7, 119]. Basketry, projectile point, and architectural styles, as well as a dental study have all been marshaled to support a northward migration of farmers [94]. Mitochondrial DNA and blood serum evidence do not readily support Hill's original arguments, but a scenario in which only Proto-Uto-Aztecan males migrated northward, bringing language and maize, and intermarrying with local females has been proposed as a way of accommodating this evidence within a migrationist framework [89, 133]. Nonetheless, Hill's reconstructions of Proto-Uto-Aztecan agricultural terms and migrations have been questioned [22], and alternative models that argue that Uto-Aztecan populations spread in the opposite direction, from northern California [105] or the American Southwest and northern Mexico into central Mexico [39, 100] remain viable.

Regardless if maize agriculture was introduced to northern Mexico and the American Southwest by diffusion or migration, ecological factors must be taken into consideration if the spread and role of farming among societies in this region is to be understood. Several relevant ecological models have been proposed. Resource imbalance models suggest that local hunters and gatherers are "pushed" to adopt agriculture when environmental changes or increasing populations create resource shortages [12, 14, 46, 52, 67, 71, 72, 102]. In contrast, "pull" models propose that floodplains and other settings provide attractive niches for farming for both migrant farmers and local hunter–gatherers [58, 65, 93, 102].

Combinations of factors have also been proposed to explain the northward diffusion of maize from Mesoamerica, and more recently John P. Carpenter and colleagues [23] suggest that a reduction in wild resources brought on by **Altithermal** aridity (ca. 5500–2500 BC) pressured Proto-Uto-Aztecan populations to split into northern and southern branches and to abandon the lower elevations in the southern American Southwest and northwestern Mexico [73]. As climatic conditions ameliorated these populations reoccupied the desert regions of the American Southwest, Chihuahua, and Sonora, and expanded northward into areas attractive for agriculture. Other models based on optimal foraging theory are neither push nor pull but emphasize the trade-offs between domesticated and nondomesticated resources [5, 31, 52]. Of course, as Matson [93] notes, the pace for the northward expansion of maize agriculture was at least partially dependent on genetic adaptability and changes within the plant itself.

EARLY AGRICULTURE IN CHIHUAHUA

The northern Mexican state of Chihuahua includes segments of two of the routes that have been proposed for the transmission for maize agriculture between Mesoamerica and the American Southwest: the uplands of the Sierra Madre Occidental and the north–south trending river valleys east of this mountain range. Both areas would also likely have been involved if maize farming spread northward along broad fronts rather than more delimited routes and thus appear crucial for understanding early maize agriculture. Nonetheless, little is known about the chronology and processes associated with the adoption and expansion of farming in these and surrounding areas within Chihuahua because only limited research has been completed there.

To begin eliminating this gap in our knowledge, we have been investigating early agriculture in three areas of Chihuahua that include two distinct ecological zones. The zones are the Basin and Range province and, to the west, the Sierra Madre Occidental (Figure 6-1 and Table 6-2). Basin elevations increase toward the west, and mean annual precipitation increases moving south and west in Chihuahua. The first investigated area is in the high basin and range country of northwestern Chihuahua where our work focused on the Río Casas Grandes Valley with its wide floodplains and excellent arable land. Here rain-fed farming (more commonly known as dry farming) is marginal and modern irrigation is widespread (see Figure 6-1). The second area is in south-central Chihuahua, also in the high basin and range country where we have worked primarily along the perennial Río San Pedro and Río Satevo, both tributaries of the Río Conchos, in the vicinity of the town of Santa María de Cuevas. Also in south-central Chihuahua, but about 100 kilometers further south, we have examined sites in the vicinity of Parral where the perennial drainages are the Río Primero, Río Santa Bárbara, and Río Sapién, all tributaries of the Río Florida. Most of these midsize drainages and their tributaries contain wide floodplains and well-defined **fluvial terraces.** Rain-fed farming is more widespread in alluvial soils, and modern irrigation farming is common. The third area is the rugged Sierra Tarahumara of southwestern Chihuahua within the Sierra Madre Occidental ecological zone (see Figure 6-1 and Table 6-2). The Sierra Tarahumara is now inhabited by Mestizo and **Tarahumara** (Rarámuri), both of whom routinely use dry farming [97].

PALEOENVIRONMENT

Research addressing paleoenvironment in Chihuahua is relatively recent, but in broad terms the results of this research correspond to findings from southern Arizona and New Mexico [51, 52]. Warmer temperatures in the early Holocene (9000–7000 BC) brought about major environmental changes. By the middle Holocene (7000–2000 BC), vegetation shifts occurred in response to combinations of increased summer temperatures and increased aridity. The late Holocene (2000 BC–present) brings the establishment of modern vegetation but with fluctuating moisture levels.

General warm dry middle Holocene conditions increases in moisture are reflected against uncorrelated episodes of lake filling and marsh development in Chihuahua and surrounding areas [25, 38, 99, 108, 141, 142]. By 3000–1600 BC

TABLE 6-2 Ecological Zones

Zone	Elevation (m)	Precipitation (mm/yr)	Biotic community	Vegetation	References
High basin and range	150–1800	325–450	Plains and semidesert grassland	Shrublands, grasslands, and woodlands	21, 122, 144
Sierra Madre Occidental	1800–2800	500–850	Madrean evergreen woodland and Petran Montane conifer forest	Conifer and oak forests	21, 32

a regime was underway consisting of high magnitude floods, moist conditions, dramatic lake high-stands, and cold lake water temperatures [34, 57, 99, p. 169; 110, p. 202; 140, 143, 146]. Southwestern United States high magnitude flooding decreased markedly between 1600–200 BC, and overall moisture regimes remained high at ca. 1000 BC [106, 109, p. 1177].

The following millennium witnessed a slow drying trend. In the Babícora Basin of central Chihuahua, modern, semiarid conditions were established [99, 108]. These drying conditions were not necessarily widely synchronous, as moist conditions continued to ca. AD 1 in some locations [115, 140, 141]. The absence of high magnitude floods facilitated floodplain building along the Río Casas Grandes until ca. 200 BC, but they resumed after AD 1 [34, 106]. However, mesic (damp) conditions did not commence again until ca. AD 500 [34, 106, 139, Figure 7.9].

The general picture is one of a warm and dry middle Holocene followed by widespread moisture increases late in the middle Holocene to the beginning of the late Holocene, a return to somewhat arid conditions following 1000 BC, then mesic conditions returning at ca. AD 500. These overall trends, however, are sometimes contradicted by studies of specific areas within the region. Further paleoenvironmental work in Chihuahua is required if the complex relationships between climatic shifts and the spread of farming are to be understood.

PREVIOUS RESEARCH IN CHIHUAHUA

In the past, research on early agriculture in Chihuahua has been directed in large part toward enhancing an understanding of the spread of maize agriculture to the American Southwest. Working in Cave A near Norogachi, located in the eastern Sierra Tarahumara (Figure 6-1).), Robert M. Zingg [151, p. 212; 152, pp. 1–43] found lithics and preserved organic material, including corn, but no ceramics. He concluded that the local sequence began with the Río Fuerte Basketmakers who farmed maize but lacked beans and pottery. Significantly, in the context of current migration debates, Zingg [152, pp. 18–31] shows a number of similarities between the Rio Fuerte Basketmaker material and that of the Colorado Plateau Western Basketmaker, particularly in weaving technology [cf. 94].

Two decades later, Robert H. Lister [79] found a few lithics and three maize cobs in the lower strata of Swallow Cave in northwestern Chihuahua, below the ceramic levels. Although lacking temporal controls, Zingg's [152] and Lister's projects provided qualified evidence that maize agriculture extended into the Sierra Madre Occidental quite early. They also fostered the idea that the Sierra Madre Occidental was a corridor by which agriculture spread north, a conclusion reinforced by the discovery of early agricultural sites in the highlands of New Mexico, such as Bat Cave and Tularosa Cave [31, 56].

Sporadic, largely unpublished, reconnaissance surveys beginning in the 1930s gradually demonstrated that there were scattered groups of hunter–gatherers and small-scale farmers in the basin and range country of southern and central Chihuahua [20, 73, 92, 107, 123]. With a few exceptions [73, 74, 85], however, work in southern Chihuahua has focused on the Sierra Tarahumara [4, 27, 28, 78, 138, 151, 152]. Collectively this work indicates that the Sierra Tarahumara has been occupied at least since the Middle to Late Archaic Period (see Table 33-1) but does not provide additional insights into early agriculture. In fact, little work regarding early agriculture was conducted in Chihuahua until we began a 4-year excavation program (1997–2001) at several sites in northwestern Chihuahua [49, 51, 120, 121] followed by two seasons of reconnaissance and testing (2002–2003) in south-central and southwestern Chihuahua [86–88].

NORTHWESTERN CHIHUAHUA

Our excavations focused on Cerro Juanaqueña, which lies at the confluence of the Río Casas Grandes and Río San Pedro about 50 kilometers east of the Sierra Madre Occidental. We also tested three other intermediate-sized cerros de trincheras sites—Cerro Torres, Cerro Vidal, and Cerro el Canelo—and conducted limited surface investigations at another nine small hilltop sites in the area [121]. All 13 of the sites are located on isolated volcanic hills distributed among a series of wide flood basins aligned along a 70-kilometer stretch of the Río Casas Grandes (see Figure 33-1). Two of the small sites are found along the Río Santa Maria, the next river valley to the east.

Cerro Juanaqueña is by far the largest of the 13 sites as it contains 100 rock rings and 50 terraces that include 8 kilometers of constructed walls. (Rock rings are alignments of rocks in circular to oval patterns.) The terraces are distributed in two groups on the 140 meters high basalt hill. More than 300 of the terraces are within a 6 hectare area on the top and upper slopes of the hill. Almost every bit of this area has been modified through clearing stones and constructing terraces, and artifact density is typically high. Most of the remaining terraces occur lower down on the lower west flank of the hill about 20 to 40 meters above the floodplain.

Dating of the four excavated sites is based on a series of 22 AMS dates on maize cupules, kernels, and cobs plus another five dates on short-lived species including three on ocotillo *(Fouquieria)* stems, one on a wild gourd *(Cucurbita digitata)* seed and one on a saltbush (*Atriplex* sp.) stem [49–51, 120]. (AMS radiocarbon dates use the accelerator mass spectrometry method that allows small samples to be

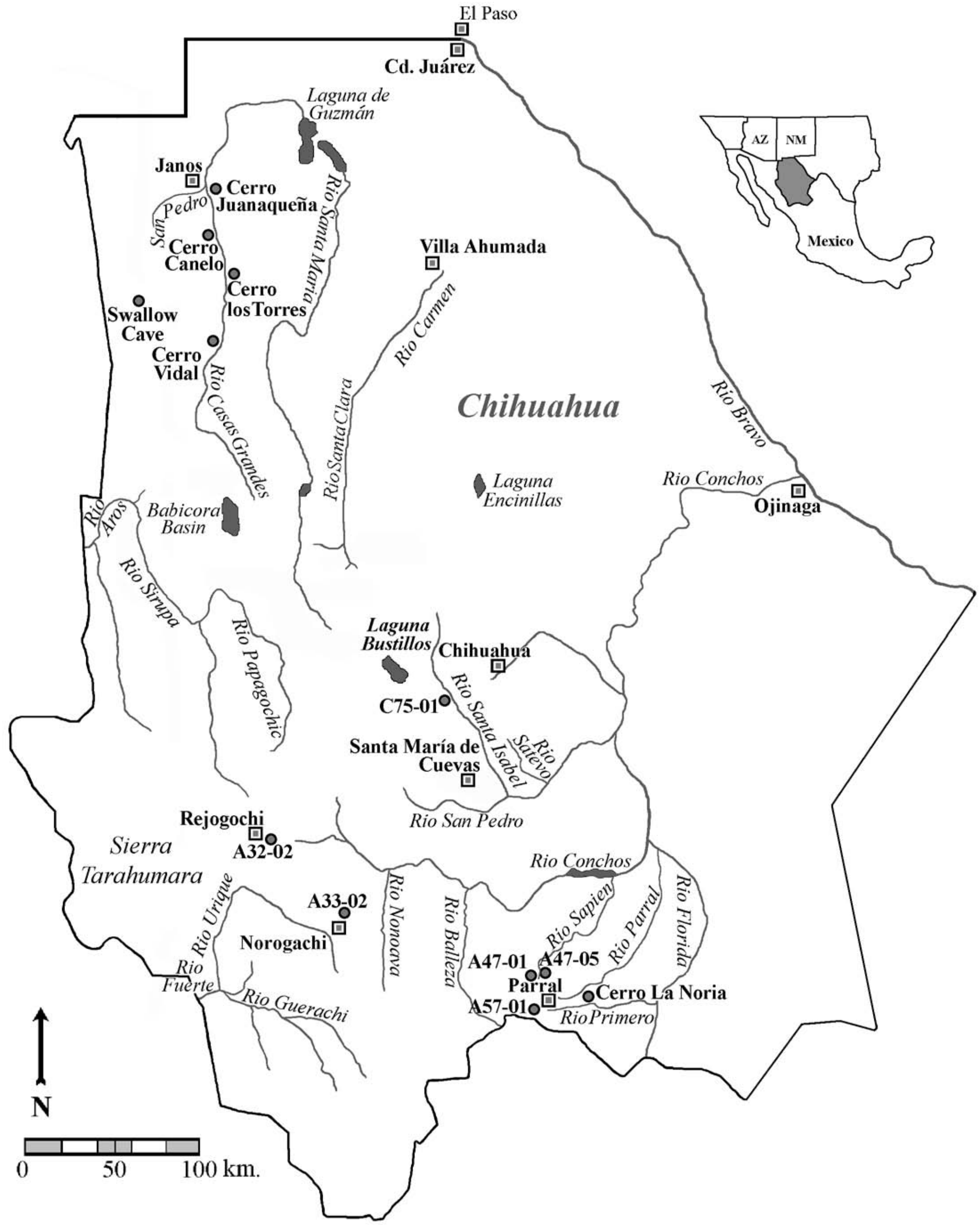

FIGURE 6-1 Chihuahua, Mexico. The solid circles represent sites mentioned in the text, and the squares are municipalities.

analyzed.) These dates suggest contemporaneous occupations at around 1300 CAL BC for Cerro Juanaqueña, Cerro los Torres, and Cerro el Canelo. Based on OxCal probability calculations, Cerro Juanaqueña itself was only occupied for about 200 years, and occupation at the other two sites may have been equally brief [18, 50, 53, 120]. None of the upper terraces at Cerro Juanaqueña show evidence of residential use following this occupation, but ^{14}C dates from two of the lower terraces at Cerro Juanaqueña do document a limited, later reoccupation between 400 and 100 CAL BC. Cerro Vidal also revealed an occupation contemporaneous with that of the second occupation of some of the Cerro Juanaqueña lower terraces.

Excavations demonstrate that the terraces were constructed by first piling the larger basalt cobbles to form an arc-shaped berm. The term "berm" indicates the terraces were constructed by loosely mounding rocks rather than stacking them as vertical walls were generally not constructed. The pocket between the berm and the hill slope was then filled with smaller cobbles, and fine sediment was used to cover the surface. The resulting terraces at Cerro Juanaqueña average about 17 meters in length and have an average surface area of 51.5 square meters. Altogether, a calculated 31,000 cubic meters of stone and sediment were incorporated into these constructions at Cerro Juanaqueña alone, and we estimate that they represent about 30 person-years of labor [54].

The terraces appear not to have been built for agricultural purposes. If the 3.6 hectares of total surface area behind all 550 terraces were planted in maize, the harvest would feed only six people for a year, assuming rainfall typical of higher elevations in the Sierra Madre [54]. In terms of labor cost per hectare of agricultural land, they would have been as costly to construct as Maya raised fields [54]. Further, they do not contain attributes typical of agricultural terraces, such as water control devices or a forward slope.

Our excavations revealed that some terraces contained midden deposits with ample burned and unburned animal bone, charcoal, and lithic debris [49–51, 120]. The 689 basin metates and 666 manos, most of which are on or near terrace surfaces, indicate that substantial domestic effort was expended to process seeds and grains. The basin metates particularly exhibited heavy wear with many being exhausted. In addition, 99 circular rock rings or alignments, with a mean diameter of 2.5 meters, were constructed on or near the terrace surfaces, some of which contained compacted living surfaces. Metates were encountered on the floors of two of these circular features, one of which also contained an informal hearth. This evidence leads us to conclude that most of the terraces were constructed as house and activity area platforms and that the rock rings often served as houses [51, 120].

At Cerro Juanaqueña and many other northwestern Chihuahua cerro de trincheras settlements, perimeter berms encircle large portions of the sites [54, 120]. The berm at Cerro Juanaqueña lies along its northern, eastern, and southern perimeters and consists of 22 linked, individual terraces forming a 400 meters long alignment. In contrast to typical platform terraces that run perpendicular to the slope, the perimeter berm on the northern and southern sides of the site runs down or parallel to the downward slope. Cerro los Torres is surrounded by an impressive perimeter berm; a similar feature defines much of the exterior boundary of Cerro el Canelo, and Cerro Vidal is enclosed by a perimeter berm on three sides while the fourth side consists of a near vertical slope. At least five of the other, smaller cerros de trincheras sites also have perimeter berms.

These perimeter berms appear to have been planned to accommodate definite spatial needs, with each constructed in a single or a few coordinated episodes. As such they suggest a level of population aggregation, organized decision making, and possibly leadership that has not otherwise been noted for this period [54, 120]. We estimate that the average population at Cerro Juanaqueña ranged between 100 and 300 people, over a span of about two centuries. We base this estimate on a consideration of several different lines of evidence, including the extent of occupied areas at specific points in time and levels of food processing as revealed through the wear documented on the ground stone basin metates [51, 120].

The archaeobotanical material recovered from these trincheras sites indicates that maize agriculture was an important economic pursuit. Fifty-one percent of 157 flotation samples were examined, and 15 of 17 terraces at Cerro Juanaqueña contained fairly well-preserved charred maize [1]. Sixteen round cobs had between 8 and 12 rows of kernels, with a mean of 10.6 rows. Kernels were of flint and flint–flour types. These traits of the Cerro Juanaqueña maize are generally consistent with a landrace of popcorn, having small, rounded, kernels, and flinty endosperm, with some lesser portion of floury endosperm. They do not overlap with those of Chapalote, an early and long persistent maize in the American Southwest, which is described as a 12–14 rowed flint or popcorn maize with isodiametric (globular) kernels marked with husk striations [2].

Amaranth (*Amaranthus* spp.) seeds were also present, and based on the presence of thin seed coats, may have been domesticated [40, 41]. In addition, a total of 16 wild plants apparently figured in the subsistence economy. These included plants of disturbed habitats, such as goosefoot (*Chenopodium* spp.), horse purslane *(Trianthema cf. portulacastrum),* chia (*Salvia* spp.), globemallow (*Sphaeralcea* spp.), lovegrass (*Eragrostis intermedia),* and some unidentified grasses (*Gramineae* spp.). Other plants used in the past include those that prefer mesic locations, such as bulrush (*Scirpus* spp.), mesquite (*Prosopis* spp.), and walnut (*Juglans* spp.), and those that can be found on drier landscapes, such as barrel cactus *(Ferocactus),* lemonade berry *(Rhus aromatica),* a wild curcurbit *(Cucurbita digitata),* and others [1]. Amaranth and wild *Chenopodium* seeds were the most commonly recovered resources after maize, and the other wild plants preserved at lower ubiquity levels, together revealing that both domesticated and wild plant foods were important in subsistence.

The most likely location for successful farming at Cerro Juanaqueña would have been the floodplain at the base of the site. A downstream channel constriction creates a flood basin forming a large expanse of alluvial sediment that is periodically susceptible to summer monsoonal flooding. This basin would have provided fairly good farm land, although drought and declining nitrogen levels may have been obstacles to farming [1]. Despite extensive trenching in the Río Casas Grandes floodplain we did not identify any evidence of irrigation canals. Of course, floodplains sometimes receive more water than plants need or can sustain, but the risk of occasional crop loss could have been offset by frequent successes.

The faunal assemblage consisted of 2550 individual specimens (NISP), and 75% of these were rabbits and hares, with jackrabbits being by far the most numerous. About 5% were pronghorn and deer, with the balance including rodents and reptiles, many of which were probably intrusive. Birds and fish also were present, and small fish appear to have been an important resource [124].

The available evidence strongly suggests that agriculture, rather than low level food production with domesticates, was practiced in northwestern Chihuahua by 1300 CAL BC. We also have concluded that Cerro Juanaqueña and the other Late Archaic Period cerros de trincheras sites probably were constructed for defensive purposes [51, 53, 76]. The isolated, steep, high hilltop locations are easily defended, the sites are compact, and they include possibly defensive perimeter berms. Moreover, terrace distributions suggest that all directions could be monitored from them, and many of the sites are visible from one to another, a characteristic of defensive locations [76]. Through a cross-cultural examination of 40 ethnographic groups that live on elevated landforms, we have shown that it is rare for nonindustrial populations to live on hilltops without compelling reasons to do so [53]. Sixty-five percent (26) of cases include defense as an explanation for hilltop living and another 20% of cases (8) can be accounted for by an absence of alternative, more convenient residential areas. The remaining cases can be attributed to environmental or farming conditions related to the avoidance of flooding or enhanced access to food resources and fields.

SOUTH-CENTRAL CHIHUAHUA

We have also conducted reconnaissance and tested sites in the basin and range province of south-central Chihuahua for the purpose of identifying early agricultural sites. It is apparent that the entire area was inhabited during the mid-Holocene interval when maize agriculture spread north. Middle Archaic and Late Archaic Period sites are relatively common, with evidence of occupation found on fluvial terraces, alluvial fans, cerros de trincheras, and in rockshelters. To date our work in this area has focused on two distinct types of sites: rockshelters with "D"-shaped terraces built in front of them and cerros de trincheras.

D-Shaped Terrace Sites

Rockshelters in the basin and range country with built-up terraces behind D-shaped walls are a phenomenon first noted by Richard H. Brooks [19]. The four that we have recorded are habitation sites are within 1.5 kilometers of fluvial terraces suitable for agriculture and have substantial assemblages suggestive of heavy use, evidenced by cobble manos, ample flaked stone debris, and faunal material. The constructed terraces follow cliff bases for 20 to 25 meters, defining the straight side of an uppercase D, and arc out about 10 to 15 meters from cliffs, suggesting a notable labor investment. We tested three of these rockshelters during 2003 [87, 88]. Work on the first was quickly abandoned due to pervasive rodent disturbance, but the other two proved more informative.

At Cueva de los Indios (C75-01), located 40 kilometers west of Ciudad Chihuahua, terrace deposits extended to 2.3 meters below surface (see Figure 33-1). The chipped stone assemblage includes at least 25 late Middle Archaic and Late Archaic Period projectiles points and abundant bifacial reduction flakes. The faunal assemblage is remarkable both for its quantity of more than 300 NISP and its composition: 80% of the identified elements are tortoise and turtle [125]. Ceramic and Recent Period components primarily rest above the Archaic materials, and a Plainview point base reveals that some Paleoindian materials are deep in the terrace fill.

Sitio Pienso (A47-05) is another D-shaped terrace rockshelter site located northwest of Parral (see Figure 33-1). More than one dozen projectile points from this site derive from the late Middle Archaic to Late Archaic Periods. A 1 by 2 meter excavation produced more than 4000 pieces of flaked stone, 25% of it from biface reduction, and not a single ceramic sherd. A diverse faunal assemblage includes turtle, tortoise, jackrabbit, cottontail, and mule deer [125]. Cobble manos, a small grinding slab, charcoal, and fire-cracked rock were also present. A recent radiocarbon date of 170 ± 40 BP (Beta 185632) on charred tree bark of an unknown species seems obviously intrusive, while an older date of 2770 ± 40 BP (Beta 182382) on a charred walnut shell is in line with the material culture assemblage. Maize was not recovered in our limited excavations or in flotation samples. (Here, we report all radiocarbon dates in uncalibrated years before present, with "present" being 1950 by international convention.)

At this point, it is impossible to determine if initial occupation of these sites predates the arrival of agriculture in the area, but if so they connote predisposition to accepting agriculture. Wirt H. Wills [147, p. 41] suggests that predisposition involves repetitive seasonal movement, limited geographical range, and resource storage capacity. Similarly, Fish and Fish [36, p. 86] suggest that experience manipulating wild plants may be an important preagricultural adaptation. The investment in terrace construction and dense assemblages at these sites are congruent with logistically organized settlement, as the rockshelters are far from being typical forager camps [13]. Such a strategy may imply wild plant intensification and decreased residential mobility [15]. Locations close to fluvial terraces may be related to the use of wild and domestic resources or both. The generalization that hunter–gatherers will move to the least portable resource and reach the others with task groups [13, 147, p. 43] may be quite applicable in this instance.

The projectile point assemblages from these sites are based largely on Middle and Late Archaic Texas types found in the Lower Pecos and Río Grande areas [136, 137]. They suggest that the principal initial Archaic Period occupations at these Chihuahua sites were no earlier than 2500–2000 BC, with continued use through the Late Archaic Period, with minimal evidence of Late Paleoindian presence.

Cerros de Trincheras

A total of nine cerros de trincheras sites are now known from the central basin and range province in south-central Chihuahua, and some of these hills have evidence of Early Agricultural Period occupation. These cerros de trincheras are consistently between 50 and 70 meters high with good views of valleys and are close to arable floodplains. They have from 5 to 40 terrace walls built with stacked rocks and circular rock outlines of structures. Nusbaum [107] first recorded several of these sites and Gerry R. Raymond [117, 118] tested three of them in 2000. One of Raymond's samples from Cerro Prieto de Santa Bárbara (site A57-01) produced a single maize radiocarbon date of about 1700 CAL BC (3410 ± 40 BP, Beta 174996) and another one from Cerro La Noria produced a maize date of about AD 100 CAL (1950 ± 50, Beta 174994) [118].

We have since re-examined one of these sites, Cerro Prieto de Santa Bárbara, mapped another site, and both mapped and tested three others. On four of these sites, we found at least one dart point that is indistinguishable from well-defined Archaic dart points in Arizona, New Mexico, and Texas, along with more recent arrow points and ceramics. Points from Cerro Prieto include two late Middle Archaic points, one is a Langtry or a variant, and the other is similar to Almagre or Augustin forms. Late Archaic Period points from this site include an untyped one and a Shumla point. Extensive bifacial reduction is evident on those hills with sizable samples of lithics, a pattern consistent with Archaic rather than Ceramic Period assemblages. This is particularly true of Cerro las Flojeras (A47-01) located within direct sight of three of the D-shaped terrace sites. These observations provide limited corroboration for the 1700 BC radiocarbon date at Cerro Prieto, although we have yet to obtain a second date in this early time range.

Cerros de trincheras of southern Chihuahua are important for several reasons. As discussed previously, in northwestern Chihuahua Cerro Juanaqueña and a series of these sites date to the Late Archaic Period and have abundant maize. The south-central Chihuahua cerros de trincheras are not as extensively developed as Cerro Juanaqueña, but they are similar to some of the other smaller, Late Archaic Period hilltop sites along the Río Casas Grandes [121]. This pattern of Early Agricultural Period cerros de trincheras extends as far north as the multicomponent Tumamoc Hill site in the Tucson Basin, and continues south into Mexico for an unknown distance [35]. Unlike cerros de trincheras in northwestern Chihuahua, those in the south-central region have substantial Ceramic Period occupations that date to ca. AD 500–1000, making their interpretation more complicated.

In summary, sites or components that likely date to the window when agriculture first arrived are widespread in the higher basin and range country of Chihuahua. These sites occur in diverse settings and in most instances imply some stabilization in settlement, which is potentially tied to the arrival of maize agriculture. Only archaeological excavation and radiocarbon dating of appropriate material will firmly establish the timing and location of early maize in this region and the degree to which local economies were dependent on agriculture.

THE SIERRA TARAHUMARA

R. G. Matson [93, p. 209] suggests that Tarahumara maize farming in the deep canyons *(barrancas)* within the Sierra Madre Occidental was the basic, original pattern for maize cultivation in the area, and that other planting patterns must have emerged from this foundation. Colonial Tarahumara agricultural strategies included floodwater and dry farming using hillsides, mesas, alluvial terraces, and floodplains and irrigation in some mission communities [29, p. 80; 75, 98, 128]. Although the broken terrain limits agricultural land, today the Tarahumara typically farm on medium to small upland valley bottoms as well as practicing limited slash-and-burn bean farming. Narrow river floodplains and small seep fields are farmed occasionally as well [3, 8, 48].

Five sites including two rockshelters, date to the Middle to Late Archaic Period (see Table 6-1, Figure 6-1). The first of these sites is a rockshelter known as Sowérare (A32-02), which is perched on a ledge below the base of one cliff and above a second cliff, in the Río Urique watershed near the community of Rejogochi. Part of the site has been thoroughly plundered, but deep midden deposits remain intact. We have excavated a single 1 m unit in the midden to a depth of more than 120 centimeters below surface. Under spoil from the looted areas, the actual midden deposits contained dense lithics, rare ground stone, and charcoal. No maize was found, but two samples of wood charcoal yielded radiocarbon dates of 800 CAL BC (2660 ± 40 BP, Beta 185630) and 1700 CAL BC (3500 ± 40 BP, Beta 182381) that are in stratigraphic order and are chronologically consistent with the midden assemblage and dart points from the site.

We have also tested a sizable cave locally known as Ganóchi (A33-02) near Norogachi, that was probably originally recorded by Zingg [151, 152]. A single 1 m unit replicated the pattern of lithics and maize below ceramics in deep cave fill as reported by Robert H. Lister [79] at Swallow Cave. The upper 80 centimeters contained abundant artifacts, including pottery and uncharred bits of cord and basketry, with remnants of a mud and grass container. The few lithics included a high proportion of biface reduction flakes. A charred maize sample from 180 centimeters, just above bedrock, dated to 400–200 CAL BC (2280 ± 40 BP, Beta 185631).

At this point it is reasonable to argue that the Sierra Tarahumara was occupied no later than the late Middle Archaic Period and potentially much earlier. Sites are widely distributed and are in locations presently well suited to small-scale subsistence agriculture. Overall, they are small, even by the modest standards of south-central Chihuahua, and our limited work has produced no indication of montane cerros de trincheras or the D-shaped terrace sites.

DISCUSSION

Maize is now documented at 2100 BC in the American Southwest, 1300 BC in the basin and range country of northwestern Chihuahua, tentatively at 1700 BC in the basin and range region of south-central Chihuahua, and at no later than 200 BC in the Sierra Tarahumara of southwestern Chihuahua. The most likely interpretation is that maize spread quickly along a broad front, from central Mexico into northwestern Mexico and then into the American Southwest, rather than along single route [9]. The spread of maize into the American Southwest is now typically argued to be either the result of migration or group-to-group diffusion. However, we suspect the processes involved are not as straightforward as this dichotomy suggests. For example, people who adopt agriculture may partially shift territorial range on a seasonal basis to incorporate arable land or occupy previously unoccupied niches, obscuring the migration–diffusion dichotomy [15].

Floodplains are potentially productive locales for farming that could attract migrants to these valleys [93]. Identifying factors that might push migrant farmers northward from further south in Mexico is more difficult. However, because the widespread formation of settled farming communities in Mesoamerica did not occur until after 1500 BC, Mexican populations may not have been at a level that would have encouraged a migration that could account for maize in the American Southwest by 2000 BC. On the other hand, it appears that the population of northwestern Chihuahua increased or became more concentrated around 1300 BC, based on the appearance of cerros de trincheras settlements in the Río Casas Grandes Valley and the evidence for intergroup conflict [51, 53, 77, p. 361, 94]. Local populations were also using less built cerros de trincheras sites in south-central Chihuahua during the Early Agricultural Period, but the nature and extent of this use and the interrelationships among the sites are currently unknown. By this time it appears that populations were rising in Mesoamerica and complex societies were coalescing coincident with improved environmental conditions for farming in northern Mexico and the American Southwest. Both the Sierra Tarahumara and south-central Chihuahua were widely inhabited before this, during the later mid-Holocene (ca. 2500–2000 BC); however, we lack the relevant data to know if and how these various circumstances were related.

Maize was a prominent component of the local economy at Cerro Juanaqueña and related sites in northwestern Chihuahua maize, qualifying it as agricultural following Bruce D. Smith's [132] scheme. We know that farming was important in southern Arizona and apparently in northwestern Sonora as well. The data currently available for south-central and southwestern Chihuahua are insufficient to allow a more complete reconstruction of subsistence other than to say maize was present in the Early Agricultural Period.

In south-central Chihuahua there are indications of increased settlement stability on a modest scale from the late Middle Archaic Period while in the Sierra Tarahumara sites from the late Middle Archaic Period onward are present but relatively small. The deep deposits at both Sierra Tarahumara tested cave sites probably reflect repeated, but not populous, occupation, and evidence for settlement stability, such as cerros de trincheras sites or D-shaped terrace rockshelter sites, is also currently absent. In contrast, the Río Casas Grandes Valley of northwestern Chihuahua seems to have been populated to a level such that warfare and aggregation associated with farming were ongoing by 1300 BC, but the nature and extent of occupations before this time are unknown. Our future research will continue to address the variability in the ecological context and spread of farming in Chihuahua and its implications for the timing, spread, adoption, and consequences of agriculture.

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