PREHISTORIC NON-IRRIGATED AGRICULTURE IN ARIZONA

A Component of the Arizona Historic Preservation Plan

Prepared for:
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April 1993

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A HISTORIC CONTEXT FOR PLANNING

Prepared for:

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Estrella Cultural Research Paper No. 3

March, 1993

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ACKNOWLEDGEMENTS

My appreciation is extended to the staff of the Arizona State Historic Preservation Office, especially Jay Ziemann, for their assistance and patience; their comments were instrumental in shaping the final form of this document. Thanks to those individuals who responded to the questionnaire sent to them as a part this project; their input contributed to the quality of the information presented herein. Thanks to Suzanne Fish and Deborah Johnson for their assistance at critical points during the project. Suzanne helped with the writing, and Deborah worked with the SHPO database and provided editorial assistance. Charles Sternberg drafted the figures, except for Figure 16 which was drafted by Deborah Johnson. Thanks to Bea Stam for help with the tables.

This document was prepared through the use of public funds for a diverse audience, including land and resource managers, land owners, archaeologists, and the general public. We hope that each audience can find something of interest herein. It is also hoped that this brief overview will stimulate further interest in the study of prehistoric agriculture in Arizona.

CHAPTER 1

INTRODUCTION

David E. Doyel and Suzanne K. Fish

Arizona residents and visitors have long been fascinated with the ancient Native Americans who created magnificent towns in the midst of an arid and challenging environment. By combining knowledge of the environment with the use of native and imported plants, native peoples developed a number of diverse agricultural traditions throughout Arizona. Their technological and social approaches to agriculture proved sustainable for hundreds of years. While several generations of archaeologists have focused their attention on the state's indigenous cultures, they have yet to develop a full understanding of how the natives actually wrested a living from their homelands. Without a concerted effort to locate and study the evidence for their diverse survival solutions, we will fail to appreciate their most impressive achievements of all.

Over time, native agriculture proved adaptable to a range of environmental conditions, including the sand-covered mesas of the northern plateau, the forested mountains of central Arizona, and the hot southern deserts. Large villages containing hundreds, perhaps thousands, of people dependent upon agriculture were present in many areas. Anthropologists and archaeologists have learned that native agricultural practices were intricately woven into the fabric of southwestern societies. Elaborate ceremonies were performed to insure abundant rainfall and the fertility of fields. Some agricultural practices are still in use by the descendants of these prehistoric agricultural societies. In Arizona, native farming peoples include the Pueblo, Navajo, Apache, O'odham, Pai, and the Colorado River tribes (Figure 1-1).

The lengthy history and diversity associated with prehistoric agriculture presents unique challenges to archaeologists and historic preservationists. Archaeologists often lack training in agricultural practices, and few studies have focused on the distribution of agricultural sites in Arizona. Native agriculture was variable and did not conform to European traditions. Since no plows, draft animals or other land-modifying devices were used, prehistoric field sites often show little evidence of former use. The study of native agriculture was also slow in developing, and in some areas farming practices were diminishing by the time of initial investigations. For instance many Gila River Pima were no longer farming by 1870, yet the first systematic study of Pima agriculture was not undertaken until around 1900 (Russell 1975).

Archaeologists routinely locate sites that represent residential, ceremonial, manufacturing, processing, and other activity areas, but may overlook the primary component that formed the basis for the community, the agricultural fields. Although exceptions exist, agricultural sites have not been recorded in a uniform manner, but instead are often listed as add-ons to other site descriptions. One objective of this study is to focus on the inherent qualities of prehistoric non-irrigated agricultural sites in Arizona.

The request-for-proposal for this project (State of Arizona 1991:4) defined non-irrigated agriculture as "agriculture undertaken without the use of canals diverted from rivers, and includes various forms of floodwater farming, dry farming, and farming that utilized small-scale acequias or ditches from springs or run-off catchments." This study of non-irrigated agriculture complements an earlier volume "Prehistoric Irrigation in Arizona" (Dart 1989), also prepared for Arizona State Parks, State Historic Preservation Office (SHPO). The latter study focused on southern Arizona, where most irrigation sites were located. Since opportunities for non-irrigated agriculture were more widely distributed, this study will address the diversity found throughout Arizona.

Why Are Prehistoric Non-Irrigated Agricultural Sites Worth Saving?

While subsequent chapters present specific issues regarding prehistoric non-irrigated agriculture in Arizona, a more general perspective is useful at this point by way of introduction. The question "Why are such sites worth saving?" is a legitimate one that should be addressed.

Prehistoric sites document the operation of past economic systems, and tell us how humankind has made a living for the past four million years. During this great expanse of time, experiments with a multitude of survival strategies have been undertaken with varying degrees of success. Archaeological sites document humankind's successes as well as its failures. Food production through agriculture has been a world-wide human survival strategy for millennia. Arizona contains unique archaeological sites that document the development of non-irrigated agriculture which supported life for several thousand years. But what makes these sites worth saving? Five general reasons can be listed:

* Prehistoric non-irrigated agricultural sites represent excellent examples of adaptation to arid environments.
* They show the viability of small-scale sustainable agriculture.
* They contain unique data regarding past subsistence activities.
* They are critical for studying the evolution of agriculture.
* They can yield information useful for present-day agriculture.

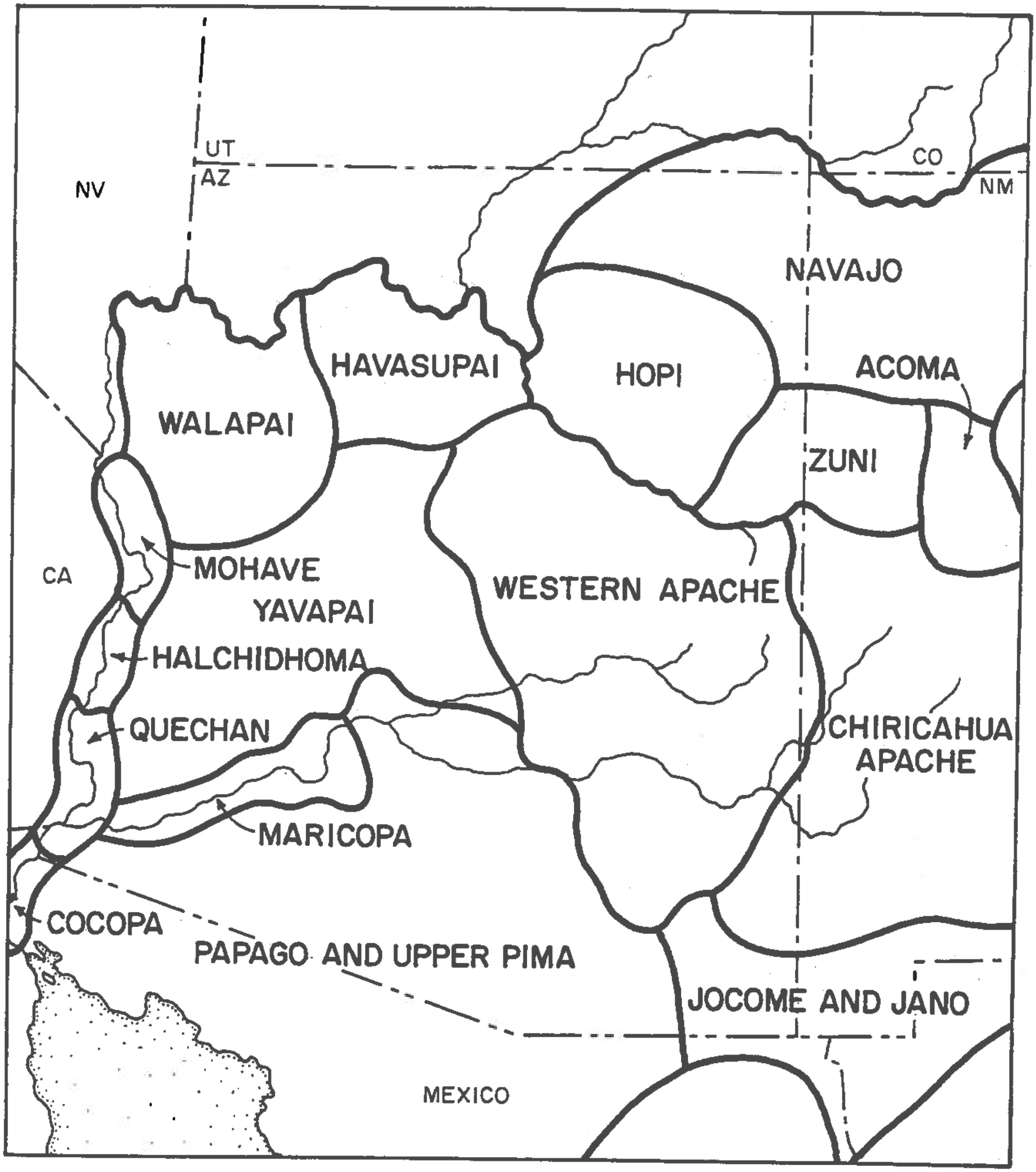


Figure 1-1. Ethnographic Map of Native Peoples in Arizona. Adapted from the Handbook of North American Indians, 1979.

The study of non-irrigated agricultural sites can contribute to a number of aspects of modern life, including research, education, recreation, economic development, and heritage preservation. Such sites help scientists understand the evolution of non-irrigated agriculture, its impact on human societies, the role of climatic change, the ecology of fields, the functioning of field systems, and changes through time. Research on these issues remains in a formative stage and has not yet become an inter-disciplinary endeavor. Scientists from varied backgrounds could productively study these issues, but will require access to field sites to conduct research, as well as access to the full range of variation among non-irrigated agricultural sites.

A consideration having both scientific and humanistic dimensions is the need to preserve cultural and biological diversity. As the world becomes highly integrated through advances in communication, and as more societies emulate the technological and organizational systems of the West, cultural diversity will decrease. The green revolution associated with modern agriculture has already attained global proportions; archaeologists of the future will document this process. History and biology teach us that as species and societies lose their diversity they become less flexible and more resistant to change. Archaeological sites, including those of interest here, retain records of the diversity of human survival strategies, which one day may be of great value to humankind.

Prehistoric non-irrigated agricultural sites contain tremendous educational potential. Most Arizonans would be surprised to learn that agriculture was once practiced throughout the state, and not in just a few areas, and that some of the most complex agricultural systems in the New World can be found here. Educational programs about agriculture and native subsistence presented in our schools and in other public programming could include information on Native American agricultural traditions. The contributions of prehistoric native agriculture to modern diets could be underscored, beginning with common items such as corn, beans, squash, chiles, and so on.

Not to be overlooked are the attitudes of Arizona's first farmers. Their agricultural traditions are important sources of inspiration and pride. "The fields are our table, and farming is our religion; the land is sacred and should not be defaced," as one Hopi told us. Prayers are said and offerings are left in fields; shrines may also be present in field areas. Native American attitudes toward traditional agricultural fields should be considered when making decisions about land-altering activities. In some cases, field sites may represent traditional cultural properties which should be considered for nomination to the State or National Registers of Historic Places.

Organizations such as Native Seeds/SEARCH promote the use of native species and traditional technologies. These organizations do an active business with that overlooked market, the home gardener, who is often interested in learning about traditional agricultural techniques (Ellis 1992). This market is expanding due in part to the large numbers of retired people who are home gardeners.

There is strong public interest in archaeology and history. Some parks in Arizona, such as Casa Grande Ruins near Coolidge and Pueblo Grande in Phoenix, have been sources of public interest for over 100 years (Doyel 1987). Some well-preserved agricultural sites currently receive protection by virtue of inclusion within our national park or monument boundaries, such as Wupatki, Organ Pipe, and Saguaro National Monuments. These accessible preserves provide excellent opportunities for research and interpretation. Hundreds of thousands of people visit archaeological parks in Arizona each year. Prehistoric irrigation canals have been preserved within several parks, but few, if any, parks feature more prosaic water-control devices such as check dams, gridded gardens, linear borders, etc. This is interesting, considering that most prehistoric people in Arizona made their living using this level of agricultural technology.

Another consideration is the potential contribution to be made to economic development by the study of traditional non-irrigated agriculture (see Evanari and others 1971 for a modern example from the Near East). Native people invested generations in developing drought and pest resistant crops that could produce good yields with low water requirements. As more people move to Arizona, and as long as our agricultural practices continue to use high volumes of water, our water supply will require continuous monitoring. Indeed, a finite water supply may prove to be the limiting factor to future growth. Research into traditional non-irrigated agricultural practices as they relate to alternative forms of economic development would seem a prudent direction for the future.

Objectives and Methodology

A major goal of this study is to provide a historic context for prehistoric non-irrigated agriculture in Arizona. Historic contexts organize information around a theme, place and time, and include information about how properties fit within particular stages of cultural development that occurred at various times and places (National Park Service 1986:7). Related goals are to provide a concise discussion of property types associated with prehistoric non-irrigated agriculture in Arizona, to evaluate each property type in terms of its eligibility for the National Register of Historic Places, and to provide directions for future work.

The methodology employed relied exclusively on archival resources and databases at in-state institutions and documents provided by the SHPO. Due to the large number of specialists working in Arizona, a questionnaire was used to obtain a sampling of ideas from the professional community. The questionnaire provided a cost-effective method to obtain supplementary information and to involve interested parties, including archaeologists, managers, and Native Americans. A total of 66 questionnaires were mailed and 26 responses were received (Appendix 1), representing the following institutional categories: academic (14), consulting firms (5), government programs (6), and Native American programs (1). Useful information was obtained from this process, and the results are summarized where appropriate.

The study is divided into five chapters and several appendices. A historic context for prehistoric non-irrigated agriculture in Arizona is presented in Chapter 2. Chapter 3 provides a discussion of property types, while Chapter 4 reviews guidelines for evaluating the significance and integrity of associated property types. The management of non-irrigated agricultural sites is addressed in Chapter 5, which includes discussions of factors that threaten their preservation, a listing of some non-irrigated agricultural sites and localities within Arizona, and priorities for the protection and management of such sites. An annotated bibliography is followed by a much longer general bibliography.

CHAPTER 2

PREHISTORIC NON-IRRIGATED AGRICULTURE IN ARIZONA

David E. Doyel, Suzanne K. Fish, and Deborah H. Johnson

Why Study Prehistoric Non-Irrigated Agriculture?

The distribution and arrangement of archaeological sites on the landscape are called "settlement patterns." In modern archaeology, settlement patterns are a basic kind of data for examining the relationships among different kinds of sites and between sites and the natural environment. Residential sites where prehistoric people lived are the most visible and well-recorded components of settlement patterns. However, other sites, including remains associated with non-irrigated agriculture, must be identified if we are to know how prehistoric peoples lived as well as where they resided. The locations of agricultural sites reveal how farming was practiced in different environmental zones and where food was produced in relation to the other land uses. The placement of different kinds of fields relative to residential sites and to religious or administrative centers are also two important aspects of the economic geography of ancient societies. The distribution of residential sites alone is insufficient to reconstruct land use patterns and their relationships to cultural and natural variables.

Farming locations identified by agricultural features provide a range of information beyond the technologies used in cultivation. By modifying the land surface and adding supplemental water in dry climates, farmers create new environmental conditions. The ecology of fields is different from that of surrounding natural zones (see Rea 1981 for an example). Crops grown in particular fields are the most obvious aspect of the culturally modified ecology. Crop types are one kind of information that can be obtained by botanical studies such as the identification of pollen, opal phytoliths, and charred plants. Other plant species that grew in and around fields are also of interest. Resources in addition to crops were present among the weeds and hedgerows of agricultural landscapes. Analyses of food bones in residential sites have suggested that animals attracted to the crops and water in fields were regularly hunted.

Information about agriculture can be acquired from studies of plant remains recovered from residential sites. Information about where and how crops were produced, however, is most reliably obtained from actual field sites. Site-specific data are required to address issues concerning prehistoric economies. Farming technologies affect societies in many ways, such as creating a need for communal effort, influencing the range of population densities, and shaping systems of land tenure. Non-irrigated agricultural sites must be located in order to assess the effects of climatic change, to evaluate risks faced by individuals or villages, and to estimate potentials for surplus production. Knowledge about farming sites is needed to differentiate between situations of sustainable production and ones in which soil exhaustion or other conditions would have necessitated periodic relocation.

All of these data taken together help to provide a picture of prehistoric risk management strategies utilized to ensure survival in spite of climatic variation. Non-irrigated technologies are correlated with the riskier kinds of agriculture in arid lands. Farming in arid areas may be diversified to offset shortfalls of rainfall and harvests from fields. Cultural institutions that emphasize sharing and exchange of agricultural products are one means of counteracting these risks. Increased sizes of territorial units to encompass many kinds of field locations is another. In order to relate these issues to prehistoric social organization, the agricultural aspects of settlement pattern must be analyzed. Results from different regions can be contrasted for a comparison of cultural approaches to the challenges of arid land farming.

Information from agricultural locations enables archaeologists to go beyond descriptions of where and how crops were grown to reconstructions of the economic structure of ancient farming. Members of farming societies were faced with decisions based on environmental opportunities and limitations, available crops and technologies, possibilities for exchange, and their own goals as individuals and members of social groups. Did they choose to specialize in certain crops? Did they intensify labor to meet changing demands? Did they attempt a large surplus for storage and exchange, or did they opt for lower but more secure yields? These questions cannot be resolved with information gained solely from residential sites. Archaeological studies of agricultural features and fields hold the key to many answers.

Prehistoric agriculture in Arizona was truly unique beyond its role in supporting the development of Native American cultures. New World farming technologies represent a human adaptation that disappeared forever after the time of contact between Indians and Europeans. Nowhere in the world today do agricultural economies without domestic animals continue to exist (only dogs and turkeys are known to have been domesticated in the Southwest). The Spanish introduction of livestock irreversibly changed the relationship between people and land in the Southwest. The dramatic nature of this change is underscored by the fact that in vast expanses of Arizona where prehistoric populations once lived as cultivators, we now maintain only scattered herds of cattle or sheep. The centers of irrigated farming of the past largely conform to the cultivated locales of the present. It is on the drier lands and along the smaller waterways that farming has disappeared--replaced, if at all, by ranching. In such areas, our predecessors grew crops with the transitory storm waters that are now lost in rapid runoff.

Those interested in the history and prehistory of the Southwest are fortunate in being able to view the past through the persisting traditions of native peoples. Nevertheless, the cultural patterns of all inhabitants of this region have been heavily influenced for three centuries by domestic livestock and other economic elements of Old World origin. Like their recent neighbors, the Native American peoples of Arizona quickly recognized the benefits of incorporating cattle and sheep into new land use strategies. Herding has been important throughout the time span reflected in living memory and most oral history. Thus, even for Native Americans, archaeological studies provide information about farming prior to the adoption of historic practices.

Surviving traces of non-irrigation agriculture, combined with modern examples of ancient techniques, are keys to reconstructing prehistoric agricultural practices. Indications of farming are among the most fragile classes of archaeological remains. Unfortunately, they are also among the most poorly documented. These agricultural features consist primarily of constructions from local rock and earth, designed to collect and control water and to enhance field conditions for crops. In many cases, such features have not been recognized because they are simple in form, occur in extensive but widely dispersed distributions, and are associated with few artifacts. When recognized, systematic recording has often been neglected. The majority of non-irrigated agricultural features are exposed on the surface or only shallowly buried. Even single episodes of activities such as off-road driving or brush clearing can cause major damage. Each year there are fewer intact examples to discover and investigate.

Definition of Prehistoric Non-Irrigated Agriculture

The State of Arizona (SHPO) Request-for-Proposal suggests that non-irrigated agriculture was undertaken without the use of canals diverted from rivers, and includes floodwater farming, dry farming, and farming that utilized small-scale ditches from springs or run-off catchments. More generally, "irrigation" could simply be defined as the artificial application and distribution of water onto otherwise dry land to facilitate cultivation (Doolittle 1990:12). Following this definition, most prehistoric agriculture practiced in the arid Southwest was "irrigated", with only dry-farming qualifying as "non-irrigated" agriculture. The reader should be aware that these terms remain controversial, and that different authors use different definitions.

Extreme variation existed in agricultural practices among the Native American inhabitants of Arizona. The Pueblo and O'odham peoples developed elaborate rituals, large villages, and a complex social organization based on very different agricultural traditions. Other groups, such as the Yavapai, planted and then ignored their crops until harvest time (Gifford 1936). Only 25 percent of the Western Apache diet came from farming, with the rest coming from hunted and gathered products (Basso 1983:468). The considerable variation recorded among historic peoples frustrates attempts to devise exclusive definitions of cultural practices (i.e. irrigated versus non-irrigated agriculture) that existed along a behavioral continuum. As Doolittle (1984:126) has noted, traditional agricultural practices do not fit into neat packages.

Types of Non-Irrigated Agriculture

Prehistoric non-irrigated agriculture in Arizona included three different strategies: floodwater, runoff, and dry farming. Many variations are subsumed under these categories. At the same time, due to similar engineering principles and to the low level of technology involved, non-irrigated fields share basic elements.

Floodwater Farming

Included in this category is overbank flooding or floodplain inundation, which is the cultivation of river floodplains or smaller drainages after spring or summer floods. This strategy requires active drainages, usually rivers or washes with high water tables, that flow with sufficient regularity to thoroughly moisten and replenish the soil. This simple strategy was common among the Colorado River people during the historic period (Castetter and Bell 1951; Stone 1991) and was probably one of the earliest forms of agriculture in the Southwest. Marshy **cienegas** and springs would also have been good locations for floodplain farming (Waters 1988).

An interesting variation of floodplain farming was practiced by the Gila River Pima near Blackwater (Hackenberg 1983:167). Swampy, slow-moving waters created islands within the Gila River that were planted without need of irrigation due to the high water table. In other situations, underlying bedrock forced river water to the surface creating favorable conditions for farming, which may have been practiced by the Maricopa near Gila Bend.

Another type of floodwater farming relied on seasonal rainfall for watering fields. This strategy is known as "ak chin", which is derived from the Tohono O'odham term "ak cin", meaning "mouth of a wash", where traditional O'odham fields are located (Nabhan 1983a). Ak chin agriculture was common among both the desert and plateau peoples (Fish and others 1992; Gasser and Kwiatkowski 1991b; Gasser 1990; Vivian 1990; Winter 1978). Ethnographic studies have provided invaluable documentation regarding this agricultural strategy (Bradfield 1971; Bryan 1929; Hack 1942; Nabhan 1983b).

Ak chin farming was more labor-intensive than floodplain inundation farming. Brush weirs, diversion features, and small ditches were often needed to direct water to desired locations. Facilities often required repairs, and new features would be needed if the flow of water in the stream changed course. The instability of field locations for ak chin farming contrasts with the other primary farming methods, irrigation and dry farming, which relied on fixed field locations. Ak chin farming does have the advantage of regular nutrient enrichment deposited by floodwaters (Nabhan 1983b; Masse 1991). Examples of ak chin fields were found in the SHPO files but were not referred to by this term, indicating an inconsistent use of terms and variability in classifying sites.

Floodwater fields were also located in arroyos or washes on the upper <u>bajadas</u> (gentle slopes at the base of mountains) and along ephemeral washes far removed from the major rivers. This strategy may have been employed by early farmers in the Southwest.

Runoff Agriculture

Agriculture based on runoff consists of multiple strategies somewhat dependent upon location and climate. In southern and central Arizona, a wide range of fixed features were constructed for the purpose of directing and diverting rain water short distances to field areas. While this strategy could be considered a type of floodwater farming (Nabhan 1983b), runoff agriculture differs from floodwater farming in that fields were often located on flat river terraces and gently sloping bajada tops rather than in arroyos and on alluvial fans (Masse 1991:210). Runoff farming systems were common in Arizona but were rare in the southwestern portion of the state due to lower levels of precipitation.

Dry Farming

Dry farming relies upon the direct application of rainfall to water crops. Hohokam non-irrigated agriculture was generally of the floodwater and runoff types (see Figure 2-1), while dry farming was common in the mountain and plateau regions of the state. Sand dune farming practiced by the historic period Pueblo Indians and by the bean farmers in southwestern Colorado are examples of dry farming as defined herein (see Crown 1984b; Masse 1979, 1991 and Woosley 1980 for different uses of the term "dry farming").

<u>Crops</u>

While the triumvirate of corn, beans and squash has received the most attention, other plants contributed significantly to the diets of prehistoric southwesterners. Three broadly defined agricultural complexes have been identified (Ford 1985:343-344). The "Upper Sonoran Complex", which consists of the common bean, summer squash, and the bottle gourd, was introduced from Mexico before the time of Christ. The "Lower Sonoran Complex" includes cotton, four types of beans, two squashes and grain amaranth, and was introduced from Mexico between A.D. 500 and 1200; these plants were resistant to the higher temperatures of the desert region. The "Southwestern Complex" includes indigenous plants that were cultivated or encouraged, such as panic grass, little barley grass, devil's claw, agave, and tobacco; other possible cultivars include chia, yucca, sunflower, dropseed, pigweed, cholla and chiltepine (Gasser and Kwiatkowski 1991a, 1991b). Other weedy species benefitted from the modified environments of agricultural fields and were most likely used, including tansy mustard, Indian wheat, spurge, plantain, globemallow and purslane (Masse 1991). Small rodents and mammals, including rats and rabbits, thrived in these environments and contributed needed protein to the diet.

There is good evidence to suggest that the desert people actively managed a variety of plants, including mesquite, cactus, amaranth, chenopods, little barley grass, and native tobacco. Species such as little barley grass (Hordeum pusillum) exhibit morphological characteristics indicative of active genetic manipulation. Other heavily utilized species, such as mesquite, show no evidence of genetic manipulation, but were encouraged to proliferate by providing optimum conditions for their growth.

Native peoples grew and consumed quantities of corn, beans and squash. Plant foods probably represented about 70 percent of the pueblo diet, with gathered plants accounting for up to one-half of the plant intake (Gasser 1982:23). Along with domesticated crops, mustard, sunflower, goosefoot, pigweed, beeweed, wild tomato, wild potato, purslane, and tobacco grew in the fields of the pueblo peoples (Gasser 1982; Winter 1978). These resources were supplemented with other native plant foods such as acorn, pinon, walnut, and juniper berries. Some cacti with edible parts, such as cholla and prickly pear, were relished.

Corn was the most important crop among southwestern farmers; it was used for both everyday sustenance and for ritual occasions. Native American peoples use corn in naming ceremonies after the birth of a child, in puberty rites, at marriages, at death, and at other important ceremonies. Corn is more than a food source to these Arizonans; it is life itself. The practices associated with corn agriculture thus take on additional cultural and psychological significance.

The survival of Native cultures that maintain "traditional" agricultural lifestyles has provided a rich legacy regarding aboriginal economic activities. It is this legacy that has allowed archaeologists to interpret many of the agricultural features distributed across the landscape. This is not to say that the historic peoples reflect all that happened in the past, but they can provide a starting point for further investigation.

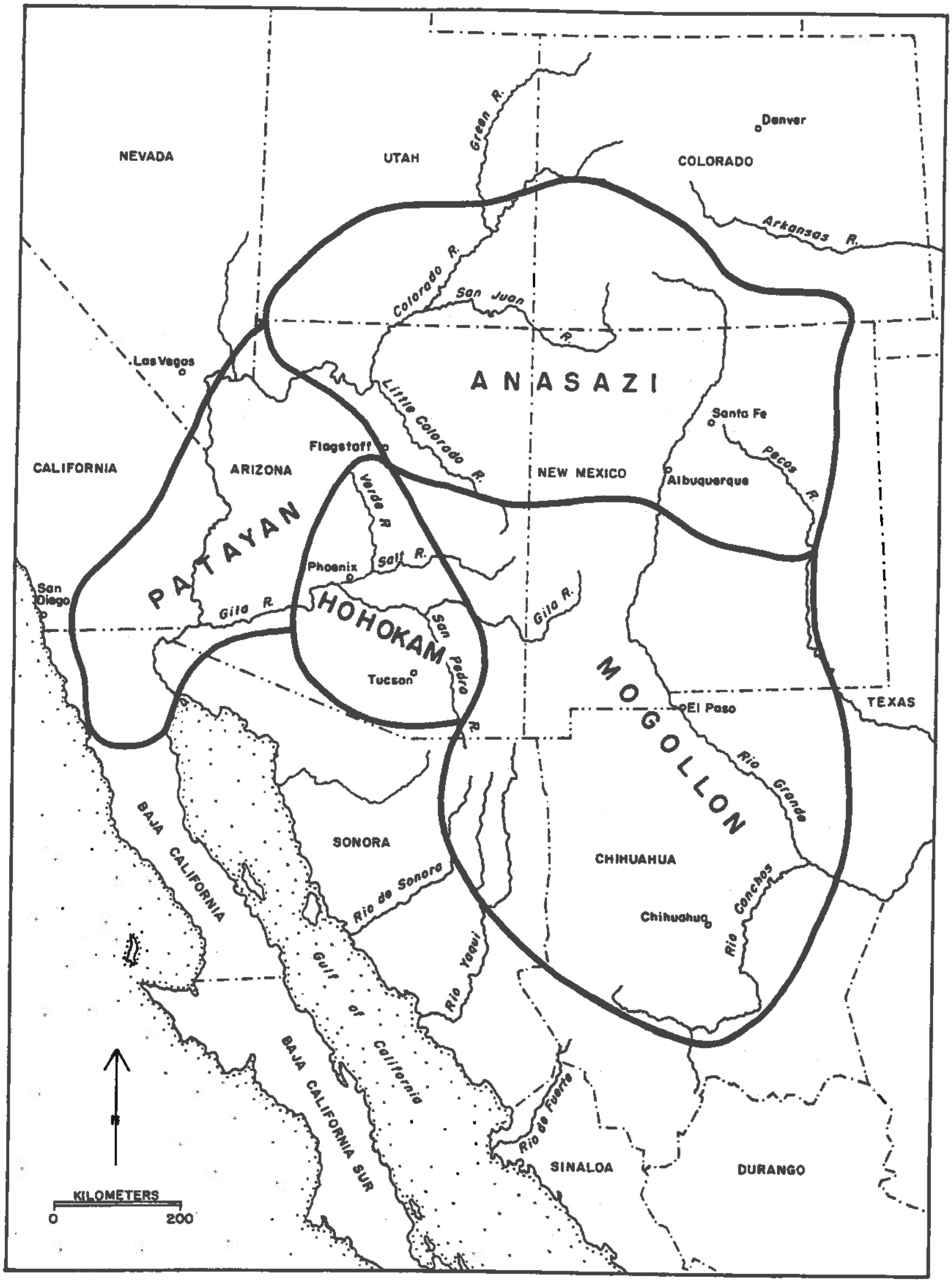


Figure 2-1. Prehistoric Culture Areas in the Southwest. Adapted from Cordell, 1984.

Origins of Southwestern Agriculture

The earliest non-irrigated agricultural features represent important information for understanding how farming was first adopted by Southwestern hunters and gatherers. The earliest methods do not appear to have included irrigation. Settlements appear earlier than previously thought, at least 1,000 years before the birth of Christ, but it is doubtful that the inhabitants were sufficiently numerous or organized for diverting large rivers and constructing canals. The earliest agricultural features are almost 3,000 years old and are likely to have been very simple; none have yet been found. A concentrated effort will be necessary to locate and date evidence for the initial methods of cultivation.

The predecessors of Arizona's first farmers are poorly known. The time of transition to farming was during the Late Archaic period. Few details are known about the hunting and gathering strategies that were followed just before the advent of agriculture, which is marked by the appearance of corn. In contrast, studies in the eastern United States have revealed the cultivation of native species for several thousand years prior to the wholesale planting of corn, beans, and squash. The importance of indigenous plants such as sunflower, marshelder, and chenopods was eventually overshadowed by cultigens of Mexican origin. Without botanical remains from the pre-corn era in the Southwest, the question of prior tending of native plants cannot be addressed.

Excavations during the 1950's at Bat Cave in west-central New Mexico yielded early corn. The apparent age of these materials, incorrectly dated to 5,000 years ago, led archaeologists to believe that farming was practiced for 3,000 years without visible impact on Native American societies. Other early corn was found in caves in the Sierra Madre Mountains in Mexico. Emil Haury synthesized these findings into a model for the diffusion of corn into the Southwest (Haury 1962). Presumably adapted to moist environments and high elevations, early corn was thought to have been transmitted from Mexico into the Mogollon Highlands of New Mexico and Arizona. Farming later spread across the Southwest when corn with broader ecological tolerance became available.

This model of agricultural origins has not been confirmed by subsequent investigation. Redating of the Bat Cave corn has shown it to be about 2,000 years younger than originally thought and contemporaneous with corn in other regions (Ford 1981; Wills 1988). Today, early corn from a variety of locations has been dated to the centuries between 1,000 B.C. and the beginning of the Christian era. This corn is botanically similar in type, and must have been suited to many different environments. The locations where early corn is found suggests that a number of non-irrigated farming techniques were employed. Numerous groups with hunting and gathering lifestyles saw the benefits of farming, even though it required remaining near fields during the growing season.

Why would pre-agricultural Archaic groups change their lifestyles to accommodate the planting of corn and other crops? Early corn in the Southwest is small in size and likely was less productive than later varieties. Wills (1988), who conducted recent work at Bat Cave, believes that hunters and gatherers grew limited quantities of corn and other crops near sites in the Mogollon Highlands as storable supplements to diets reliant on wild food. The mountains provided sparse resources in early spring, but bountiful harvests of native resources later in the season. Crop harvests furnished a predictable supply that could be stored to support early spring occupations at mountain camps. During this time, the location and condition of developing wild resources could be noted and plans made accordingly. Rather than a major component of the diet, this early corn was more a means to improve the efficiency of foraging.

A different arrangement of early farming settlements has come to light in the desert basins near Tucson and in southeastern Arizona. Exciting new work has revealed previously unknown settlement patterns, including small clusters of pit houses accompanied by burials, middens, and large, bell-shaped storage pits predating the time of Christ (Fish and others 1992; Huckell 1990). Examination of burned vegetal remains shows a substantial proportion of corn among recovered plant remains. Sites are located alongside large drainages. Floodplains appear to have been favored field locations for farming. Additional site locations suggest early farming of low basin alluvial fans and mountain edges in the Tucson vicinity.

Corn about 3,000 years old has been found in the northern Southwest in the Four Corners region. The earliest dates come from rock-shelters, caves, and one small surface site, most of which include storage pits (see Matson 1991 for an excellent summary). The chemical composition of human bone and plant remains in middens and in preserved human feces provides evidence for appreciable amounts of corn consumption by Late Archaic peoples. Matson believes that both corn and farming techniques from Mexico required environmental conditions like those in the warm deserts of southern Arizona. After farming began in the desert regions, migrants later carried crops and agricultural lifeways to the Anasazi and Mogollon (Figure 2-1). The similarities between projectile point and basketry styles of southern Arizona and those of the north support this hypothesis. According to this view, newcomers, rather than Plateau Archaic populations, were the first farmers in that region.

Knowledge about the Late Archaic farmers is sketchy, and ideas may change dramatically with new discoveries. Dates between 2,000 and 3,000 years ago for sites with corn show that Late Archaic groups across the Southwest became cultivators long before the addition of pottery. Ceramic styles help to distinguish broad traditions among Southwestern archaeological cultures including the Anasazi, Mogollon, Hohokam, and Patayan. These societies, located in the plateau, mountains, and desert, respectively (Figure 2-2), began to differentiate and develop during the early centuries of farming life. Factors contributing to this process are embodied within the agricultural sites of Arizona's first farmers.

The Evolution of Regional Agricultural Traditions

The transition to agriculture is a topic of major theoretical and historical significance not limited to particular societies and places. The regions ascribed to the Hohokam, Mogollon, Anasazi, and Patayan contained resident Archaic populations which appear to have formed the demographic basis for later agricultural phases (Doyel 1991a; Matson 1991; Simmons 1986; Vivian 1990; Wills 1988). Archaic occupations have been documented throughout the Colorado Plateau. Early pit house villages often underlay the stone pueblos found in the Mogollon Highlands. Few early sites have been found in the Phoenix Basin, although early farming sites have been found near Tucson. The absence of preceramic populations in the Phoenix Basin suggests a high degree of contrast between the evolution of agriculture in this area and elsewhere in the desert region. Questions of this nature are of interest to archaeologists and have a bearing on research designs necessary to investigate the evolution of non-irrigated agriculture.

It is probable that sedentary villages developed across the Southwest because of a concentrated and significant increase in crop yield and food value to be had with agriculture by comparison to widely distributed native food plants. Labor intensification would have been required to obtain higher yields to sustain larger, settled populations. Some degree of specialization may have been necessary to free-up a portion of the labor force to care for agricultural resources. This process may have led to changes in social organization designed to incorporate agricultural resources into subsistence patterns, which may imply some type of larger political organization for successful management. Populations capable of producing and storing agricultural produce could have played a key role in trade networks involving areas that did not offer environments conducive to large-scale food production, but had other environment-specific resources to offer in return.

The Southern Deserts

The most important survival factor in the desert was water. Large tracts of potentially exploitable desert resources reveal no trace of Hohokam use, apparently due to a lack of water. A technological solution to water availability was the construction of earthen reservoirs that were used to store water captured during storm runoff. Reservoirs were incorporated into canal systems at large village sites, such as Los Muertos and Las Colinas in the Phoenix area. Reservoirs were used as water sources for personal and domestic use and, in the more arid areas, for agricultural purposes (Bayman and Fish 1992, Bayman 1992).

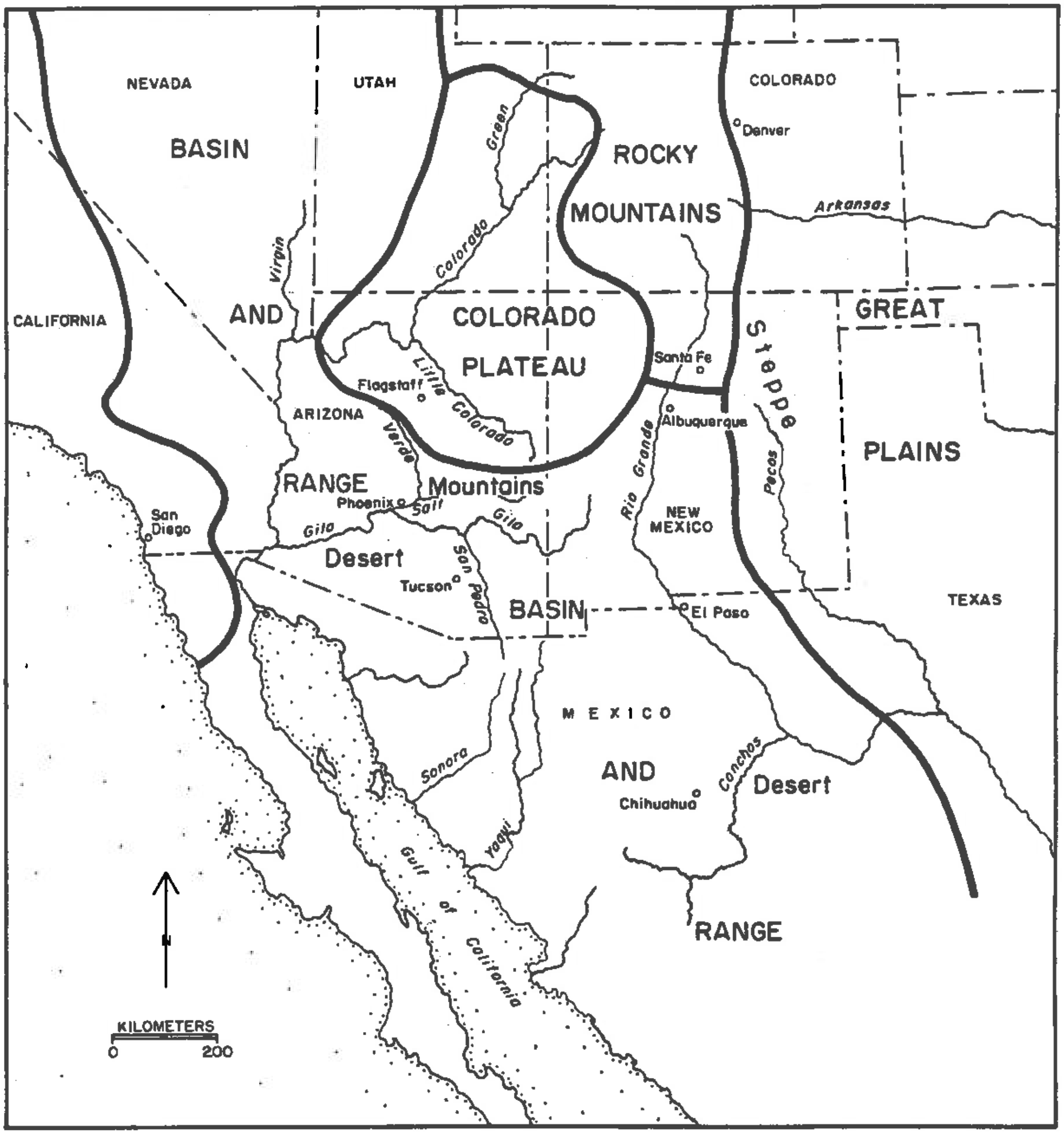


Figure 2-2. Physiographic Map of the Greater Southwest. Adapted from Cordell, 1984.

Along the rivers and arroyos, overbank flooding had created broad floodplains. Broad, flat surfaces called terraces also existed along the floodplains. Large irrigation canals, for which the Hohokam are famous, were constructed on the floodplains and on the terraces, the latter being located above the active flood zones. Canopies of trees lined the drainages, while a diversity of animal and plant life abounded. Moving away from the drainages, the land slopes gently upward toward the mountains and forms bajadas. Streams and arroyos cut through the bajadas and spread their waters onto the floodplains. Bajadas were rich in plant and animal life and provided numerous farming opportunities.

By the time of Christ, small hamlets based on agriculture, hunting, and gathering were present in the upland areas in southern Arizona and throughout the Southwest. A cultural pattern including pit houses, red and brown pottery, flexed burials, large projectile points, floodwater farming, basin metates and handstones, shell jewelry, and cloud blower pipes existed between the Phoenix Basin and the Rio Grande (Doyel 1993a). This cultural pattern and time period is known as the Early Formative (A.D. 0-700).

Research near Tucson has revealed a long-term settling-in process by local populations, suggesting that the transition to agriculture in this area was based upon sedentism developed during the Late Archaic period in the resource-rich upland aspect of the Sonoran Desert (Fish and others 1990). Late Archaic residential sites reveal a consistent presence of corn and storage pits, which suggests a major dietary reliance on corn. Near-river localities show the greatest occupational density, and are associated with small reservoirs. Nearby alluvial fans provided localities to plant crops and to harvest stands of seedy annual plants. A basic settlement pattern of multi-site communities was established during the Late Archaic period and continued until the Hohokam Classic Period (Fish and others 1990).

The high rainfall combined with diverse natural resources in the Tucson Basin provided a basis for residential stability that culminated in the transition to agriculture. The higher rainfall (over twice the average in Phoenix), combined with access to a wider range of resources, provides a high level of contrast to the Phoenix Basin. Based on current evidence, only after a commitment was made to floodwater agriculture in the uplands, perfected by generations of experience, did a successful sedentary adaptation appear in the Phoenix Basin. The earliest evidence of agricultural reliance in the Phoenix Basin - the Red Mountain phase - appears as a develped pattern, including pottery, storage, architecture, and inferentially, improved water control technology (Cable and Doyel 1987).

Direct evidence of agricultural practices dating to the Early Formative period is lacking, but the permanency of the houses, the presence of small villages and higher population levels suggest that more intensive production systems had developed. Corn remains are common in sites, and the appearance of the trough metate and two-handed mano technology, designed for grinding corn, further suggests increased reliance on agriculture. Floodwater farming, which was most likely practiced during this period, can be intensified by using water control features, such as diversion dams, ditches, and levees, to increase the amount of cultivated land. Unfortunately, subsequent land use and flooding along the floodplains has erased the traces of these early systems.

The Phoenix Basin Hohokam may have maintained a flexible settlement pattern during the Early Formative period. Permanent villages were located near the floodplains on the edges of the first or second terraces. Using the Gila River Yuman people as a model (Kelly 1977), segments of the population may have dispersed during the growing season into smaller specialized hamlets; some of these were located in the floodplain close to agricultural fields, while other sites were located in the foothills near native resources.

Deployment of irrigation technology during the subsequent Late Formative period (ca A.D. 700-1100) opened new agricultural lands removed from the river floodplains. The growing importance of agriculture is revealed in the presence of specialized small-structure sites located along canals and other farming sites between primary villages or in outlying areas throughout the Basin. The stability of agricultural field locations and the labor costs associated with canal construction and maintenance stimulated more cooperation and economic ties among family groups. A commitment to irrigation agriculture was a strong factor in reducing residential mobility and promoting village stability. Irrigation agriculture placed a premium on labor, which encouraged an increased birthrate, as well as the inflow of labor from adjacent areas as the system expanded beyond the Phoenix Basin (Doyel 1991a).

The innovations dating to the Late Formative period had lasting effects on Hohokam society and those surrounding the Phoenix Basin area. Deployment of irrigated and non-irrigated agricultural systems resulted in sedentary lifestyles, population growth, and ritual elaboration, culminating in a period of rapid cultural change and growing cultural complexity (Cable and Doyel 1985). A system of villages containing ceremonial ball courts developed during this period, which facilitated trade and exchange. By A.D. 1050, over 225 ball courts had been constructed, with 60 percent located within the Phoenix Basin (Wilcox and Sternberg 1983).

The earliest evidence for agriculture along the Colorado River also occurred during the Late Formative period. By A.D. 900, villages supported by non-irrigated (floodwater) agriculture, supplemented by fishing, plant gathering and hunting, were common in the Patayan area (Stone 1991:61). Trade in subsistence products with upland groups may have contributed to the economic security of both riverine and upland groups (Stone 1991:66). Similar economic patterns appear to have survived into the historic period. There is also evidence to suggest interaction of an unspecified nature between lowland Patayan groups and Hohokam groups located along the lower Gila and lower Salt Rivers between Gila Bend and Phoenix.

By the end of the Late Formative period, villages reliant on agriculture were distributed throughout the Gila-Salt region. Some villages contained several hundred people. Reservoirs were constructed to maximize settlement opportunities in outlying areas (Bayman 1992; Teague and Crown 1983). Diverse site locations were occupied, including non-riverine areas, where extensive run-off systems were developed. This period was one of "niche-packing", wherein populations occupied a wide range of environments.

The Classic period (ca. 1100-1450) was a time of change. Long-held patterns of community organization underwent radical restructuring. Changing spatial and architectural patterns within villages suggest the development of new social relationships. Increased reliance on intensive agriculture, and specifically canal irrigation, had a profound influence on Classic period culture in the Phoenix Basin.

Agricultural intensification and subsistence diversification were both aspects of Classic period subsistence. Intensification is indicated by the hundreds of kilometers of irrigation canals constructed within the Phoenix Basin area. Diversification is indicated in both the range of crops and native species used and in the types of agriculture practiced. Communities on the edges of the Phoenix Basin, such as Brady Wash, McClellan, and Marana, emphasized non-canal irrigation agriculture along with increased use of agave and mesquite. Communities located on the northern and eastern sides of the Basin where rainfall was more abundant emphasized run-off agriculture on the terraces above the rivers.

New forms of non-irrigated agricultural features known as "trincheras" appear during the Late Formative to Classic period transition and continue throughout the Classic period in southern Arizona. Trincheras sites are characterized by walls and terraces made of dry-laid stone placed on the slopes and tops of hills; in southern Arizona the hills are usually of volcanic origin. The trincheras site located above the Hohokam site of Los Morteros along the Santa Cruz River near Tucson contains 250 such terraces. Some of these were used for habitation, while other were used for crop production (Fish and others 1992:34).

Between A.D. 1350 and 1450, the Classic period mysteriously ended. Small sites lacking the complex traits of the Classic period have been located within the Phoenix Basin and represent the Polvoron phase. The presence of corn and cotton documents the practice of agriculture, but whether or not irrigation systems were operative remains in question. The locations of sites away from the rivers, such as El Polvoron and Brady Wash, suggest that a diversified settlement-subsistence pattern was present. The Polvoron phase appears to represent a transition between the Classic period and the less complex cultural patterns of the Protohistoric period (Doyel 1991a). The respective roles of non-irrigated versus irrigated agriculture in Protohistoric period (A.D. 1450-1700) subsistence systems remains a significant question.

Central Mountains

Water was not a limiting factor for agriculture or settlement in the Central Mountain zone. Other variables, however, operated to render agriculture precarious, including the absence of flat land, poor exposures, thin soils, slope erosion, and short growing seasons. The limited-scale agriculture conducted during historic times in the mountains, even given modern technology and crops adapted to northern European conditions, may provide an indication of the limited viability of agriculture during the prehistoric period. Techniques were developed to ameliorate the effects of environment and climate through the use of ridging, mulching, staggered planting, and planting near thermal masses (Peterson 1988:123). Archaeological research has demonstrated that some areas did witness the growth of large communities based on agriculture for short periods of time during prehistory.

Archaic period use of the Central Mountains is known for numerous localities (Macnider and Effland 1989). Archaic occupation may have represented a part of an economic cycle, focusing on hunting and gathering. Redman and Hohmann (1986) reported a date of A.D. 300-600 for an aceramic level in Horton Rock Shelter near the Payson Basin that was associated with large projectile points.

Maize pollen has been found in association with Archaic materials at both the Cienega Creek Site near Point of Pines and in the Cibeque area (Matson 1991). Similar occupations occur in the Mogollon Highlands to the east (Wills 1988). Early agricultural occupations in the Central Mountains would consist of technological assemblages similar to the Archaic with the addition of plainware pottery. The cultural relationship between the Archaic period occupants and the subsequent early ceramic-horizon people remains to be identified.

Pit house and other habitation sites containing metates and pottery have been recorded at elevations above 2100 m (7000 ft) on the Tonto National Forest (Macnider and Effland 1989; Doyel and Macnider 1991). Non-irrigated agriculture may have occurred under well-watered alluvial conditions in meadow and stream-side situations in the Central Mountain zone. It is also possible that native resources were equally attractive in these situations.

Water control and soil retention facilities including rock piles, check dams, and terraces have been reported from Buckhead Mesa and the Brushy Basin-Cedar Mesa localities at elevations below 1650 m (5,500 ft) southwest of Payson. Bedrock metates, roasting pits, ground stone tools, field houses, and storage structures have also been recorded (Doyel and Macnider 1991). Sites containing check dams and other water control features have been recorded in the Payson area near Shoofly Village; much of this activity dates between A.D. 1000 and 1200 (Doyel 1991b; Hohmann and Redman 1988).

Woodbury's (1961) pioneering study of prehistoric agriculture at Point of Pines documents a range of variation in non-irrigated features that date to the period between A.D. 1000 and 1400 when the local population was at its maximum size. The tops, and perhaps the bottoms, of ridges containing sufficient soil were farmed using a runoff strategy that included a variety of water control features situated in diverse topographic and environmental settings, including bordered gardens, check dams, and contour terraces. Many features appear to have been designed to prevent soil erosion, but also served to conserve moisture. Slopes were lined with stone terraces parallel to contours with gradients of less than five percent to prevent water loss through runoff. Collection of rocks and boulders to construct the terraces provided cleared spaces for growing crops.

Research in the Grasshopper region suggests that prehistoric populations exploited different elevations for resources on a seasonal basis (Reid 1989). From Grasshopper Pueblo, located below the Mogollon Rim at around 1800 m (6,000 ft), groups of people moved south into the chaparral and transition zones between the spring and fall seasons to gather plants and to farm, apparently using alluvial and groundwater techniques. Late in the sequence, this mixed-subsistence strategy was replaced by agriculture-dependent villages. Agriculture near Grasshopper apparently occurred in meadows with sufficient moisture and soil development, and perhaps in small fields in conjunction with water control features (Tuggle, Reid and Cole 1984).

Sullivan (1982, 1984) contends that small plots of thin soil were enhanced by intentional burning of the accumulated duff (pine needles, etc.), often located in non-alluvial soils in upland settings. This "burn-plot farming" would have been a cultural solution to environmental limitations on agricultural productivity in the Mogollon area (Sullivan 1982:9). He suggests that this strategy was practiced in the Grasshopper region.

Hundreds of sites associated with Mogollon communities based on agriculture have been reported from the Reserve and Pine Lawn areas located along the Arizona-New Mexico border. A similar situation likely existed on the Arizona side of the border. Early pit house sites were located near large floodplains. Sites in upland areas were located along drainages where agriculture could be conducted. Dams and other features were constructed to divert water (Accola 1981:161-164). Agricultural diversification occurred through time, culminating in multi-site communities distributed around central sites with communal lodges. Field houses, farmsteads, check dams, "rock spreaders" (diversion features), and possibly dikes and wells were associated (Peterson 1988:114, 123). Farming strategies appear to have involved both groundwater and alluvial systems. Agricultural systems and local populations were at their maximum distribution during the Reserve phase (ca. A.D. 1000-1100); most agriculture appears to have been based on groundwater farming strategies (Peterson 1988:125).

Colorado Plateau

Like the desert, water was the critical variable for agriculture on the arid northern plateau. While modern corn requires 45-60 cm (18-24 in) of water, traditional varieties of maize can be grown on the Hopi mesas with only 25-33 cm (10-13 in) (Vivian 1992). With an annual average of 20 cm across the Plateau, supplemental moisture was often needed to grow crops.

The Chaco culture, centered in northwestern New Mexico, arose in one of the most inhospitable portions of the Anasazi domain. Research has suggested that the Chaco cultural expression represented a social and technological adaptation that touched most of the Anasazi world, perhaps reaching as far west as Flagstaff, Arizona. Chaco-related villages existed in northeastern Arizona along Chinle Wash, the Rio Puerco, the Zuni River and elsewhere, making the Chaco example relevant for this discussion (Gilpin 1989a; see papers in Doyel 1992). At the heart of the debate regarding the Chacoan adaptation are questions about social organization and subsistence practices focusing on agriculture.

Within the lower 15 km of Chaco Canyon, 28 drainage zones on the north side of the Canyon produced run-off that was used to water fields. Vivian (1992) speculates that the canyon bottom on the north side was developed into gridded fields, with a total catchment area of 4,250 ha for 400 ha (1000 acres) of farmland.

Vivian (1992) feels that a cultural focus was placed on the management of labor to maximize the unpredictable nature of the water supply. Due to the nature of summer storms, the latitude for crop watering may have been only a matter of hours, so that coordination of labor for achieving maximum results would have been critical for success. Individual drainages may have been regulated by corporate groups living in nearby great houses or within the community. In this view, the massing of population near fields in villages and great houses may have been a direct response to the type of agriculture practiced by the Chacoans.

Three different methods of floodwater farming were practiced in Chaco Canyon. The method used in any particular situation was determined by the nature of the water source: 1) ak chin and sand dune farming were practiced where fields received water along the edges and mouths of drainages that spread across side canyons, 2) sheet runoff was used to water gardens on natural stone terraces in cliff areas, and 3) stone terraces were constructed to hold soil and water that drained over the cliff edges (Vivian 1992). Also present were canal-fed fields in the canyon bottom and dry farming fields located along the canyon edges. Stone terraces, diversion canals, reservoirs, dams, and gridded fields are associated with agricultural fields in Chaco and in surrounding areas. The use of check dams and linear borders increased through time, while mulched gardens were added later.

Dean (1992) has pointed out that around A.D. 925 when the Chaco culture was being formulated, environmental conditions shifted from incised drainages and low water tables to aggradation (channel filling) and rising water tables, both of which would have been beneficial to agriculture. Alluviation would have recharged the soil with nutrients while higher water tables made precipitation of secondary importance in crop production. According to Dean, environmental conditions favorable to agriculture existed across the Colorado Plateau between A.D. 900 and 1130.

As populations increased, elaborate water management systems more dependent on rainfall were developed to increase production. Reliance on water harvesting techniques made the system more vulnerable to high frequency natural processes such as variation in rainfall. A severe drought began around A.D. 1130 that lasted for several decades. Combined with lower ground water levels and less effective redistribution systems, the Chaco culture underwent reorganization that included abandonment of numerous great house communities and the growth of new centers.

The Chaco example reveals that agriculture was not an unchanging form of land use during prehistory. Other examples can be cited. In the upper Little Colorado River Valley, floodwater, ground water, and sand dune farming systems preceded irrigation systems, which developed late in the prehistoric sequence (Doyel and Debowski 1980). During the Basketmaker and early Pueblo periods, farming hamlets were distributed in a variety of environmental settings. Late in the sequence, gridded gardens, check dams, terraces and canals appear in association with large pueblos along the river (Longacre 1964; Plog and Garrett 1972). Like Chaco, the archaeology of the Little Colorado River Valley reveals that agriculture as a subsistence strategy represented an integral component of a larger adaptive system that involved environment, population, social organization, and technology.

Other agriculture sequences can be identified for the plateau area. Near the Grand Canyon, non-alluvial landforms in the upland forest areas were abandoned in favor of lower, unforested alluvial settings after A.D. 1300 (Alan Sullivan, personal communication 1992). Near Homolovi, a sequence of use from sand dunes, to small drainages, to diversion systems can be identified (Charles Adams, personal communication 1992). Water control facilities become more diverse through time in the Chinle Valley (Gilpin 1989b).

Research Issues Associated with Prehistoric Non-Irrigated Agriculture in Arizona

Regardless of the area they inhabited, prehistoric Arizonans were ingenious when it came to producing crops from the land, even in areas where food crops are not grown today. Their agricultural solutions and systems reflect highly technical knowledge about their environment and the interplay of climate, geography, geology, and water in the process of food production. Research has also shown that non-irrigated agriculture was not a static, unchanging occupation during prehistory; new strategies were developed in various places over time. Agriculture was a dynamic aspect of aboriginal economic systems, and not all regions experienced the same developmental sequences. It does appear that non-irrigated techniques preceded any attempts at irrigation throughout the state, while irrigation was possible on a large scale only where permanent reliable water sources existed, generally along major rivers with consistent flow characteristics.

Research conducted to date has indicated that prehistoric agricultural strategies were often closely articulated with population, climate, environment, technology, and with socio-economic processes including trade and warfare. These dimensions of prehistoric agricultural variation and change in Arizona require explanation in anthropological, ecological, technological, and historical terms, which can be accomplished through the development of overviews and research designs.

Research themes can be identified for prehistoric non-irrigated agriculture in Arizona. These range from historical (time-space distributions), to technical (specialized analyses), to site-specific studies (field systems), to theoretical (regional models). Some general themes are listed on the following page.

Time, Space and Form

1. Defining "non-irrigated" agriculture.
2. Identifying the evolution of non-irrigated agriculture.
3. Identifying and dating sites and features.

The Ecology and Function of Agricultural Field Systems

4. Identifying what crops were grown in what fields for how long.
5. Understanding how agricultural systems worked.
6. Interpreting agricultural feature function.
7. Understanding micro-niche variation in agricultural fields.
8. Understanding the interactions of variables that affect crop production, i,e. temperature, moisture and soil.
9. Understanding the dynamic ecology of field systems.
10. Determining the amount, location and extent of areas under cultivation through time.
11. Developing methodologies to study agriculture, i.e. biological remains, soil chemistry, phytoliths, vegetation change.
12. Identifying the carrying capacity of different field types and comparison with irrigated agriculture.
13. What factors limited or encouraged use of rock pile fields?
14. Why weren't rock pile fields used during the historic period?
15. Were other non-irrigated agricultural strategies not continued into the historic period?
16. Identifying the limitations of non-irrigated agriculture.
17. Identifying non-irrigated agricultural strategies that may have been used in association with irrigation.

Environmental Analysis

18. Identifying technologies detrimental to the environment.
19. Identifying the spatial applicability of geologic-hydrologic models to predict variation in production.
20. Modelling Historic period-induced changes in river systems.

Socio-economic Implications

21. Understanding the integration of non-irrigated agriculture into broader subsistence systems; i.e. dietary contributions.
22. Understanding the role of non-irrigated agriculture within the broader context of land use systems.
23. Understanding the related social, managerial and religious (ritual) components.
24. Assessing the socio-economic significance of food production beyond subsistence economies.
25. Understanding the relationship between the degree of sedentism and the intensity of food production.
26. Recognizing and researching the distinction between food production and agriculture.

Spatial Distribution of Prehistoric Non-Irrigated Agricultural Sites in Arizona

Statewide Data Bases

The computerized databases housed at the Arizona State Museum (ASM), Arizona State University (ASU), and the State Historic Preservation Office (SHPO) were queried to obtain information on the distribution of prehistoric non-irrigated agricultural sites in Arizona. Approximately 22,000 site records exist in the AZSITE database at the Arizona State Museum, but not all records have been entered into the new format. The database is not structured to address queries regarding the distribution of non-irrigated agricultural sites due to the general and non-exclusive terminology in use, a situation that is currently being addressed (Ken Rosen, personal communication 1992). Queries were made using several different variables, i.e. agriculture, rock piles, etc. that yielded counts totalling several hundred sites. Due to the limited utility of the data, a plan to generate maps showing the statewide distribution of non-irrigated agricultural sites based on AZSITE data was abandoned.

The ASU database contains 5,000 records, but many are incomplete and are being updated (Michael Barton, personal communication 1992). Using the variable "water control feature", 316 sites were found to have water control features. Without referencing individual site forms, however, it is impossible to determine what type of water control is present, i.e. irrigated or non-irrigated.

Queries were made to other agencies within the state. The Bureau of Land Management database management system duplicates AZSITE (Connie Stone, personal communication 1993). The records housed by the Navajo Nation Archaeology Department (NNAD) in northern Arizona are not computerized and require hand searches of individual site files for information (Larry Benally, personal communication 1993).

Two strategies were employed to obtain information on the spatial distribution of prehistoric non-irrigated agricultural sites. One strategy was to summarize the information available in the SHPO database. It should be pointed out here that we were attempting to use the SHPO database for a function for which it was not intended. The database is a repository for compliance-related documents, and is not intended to serve as a comprehensive library of resources in the state. The database does **NOT** include information from federal agencies such as the BLM, BIA, National Forests, State or National Registers of Historic Places, or the Central Arizona Water Control Survey. The SHPO database does represent the most viable option for obtaining quantitative information, and the results provided here should be evaluated with the above comments in mind.

A second strategy was to search the literature for relevant data. Unfortunately, few comprehensive overviews exist for Arizona that contain the desired information. In sum, due to limitations in the databases and to the methods of reporting sites in the literature, this analysis is not comprehensive, but does provide an overview of the distribution of non-irrigated agricultural sites in Arizona.

State Historic Preservation Office Database

The SHPO Cultural Resource Library contains 4,800 references on the archaeology of Arizona, including both historic and prehistoric. Of these 4,800 reports, 600 have not been catalogued. Of the 4,200 catalogued entries, about 2,400 have been inventoried for data to be included in the database. Therefore, the database accessible for computer searches consisted of 2,400 references, or 50 percent of the total resources in the SHPO Library.

A search was conducted using twenty three (23) variables composed of two thematic categories (A1: Agricultural Food Production, Processing and Utilization, and A7: Utilization of Water Control Features and Systems), two site types (02: Water Control System, and 10: Agricultural) and nineteen (19) key words relating to prehistoric agriculture (Acequias, Agricultural, Agriculture, Ak Chin, Borders, Canal, Canals, Check Dam, Fieldhouse, Field House, Gridded Gardens, Irrigated, Non-Irrigated, Reservoir, Rock, Springs, Terraces, Trincheras, and Waffle Gardens) to obtain a listing of catalogued, inventoried references including any one or more variables. This list included duplications due to cases where more than one variable was present. Since the computer could not sort out duplicate reference numbers, this was done by hand to obtain a primary list of 125 references which referred to one or more variables out of the 2,400 inventoried references. As work progressed, 13 more references were added to the original list for a total of 138, including two National Register Nomination files. The resulting list was used as a time-saving strategy to obtain references from the library for study, and eliminated looking at 2,267 references by hand.

Abstracts, data tables, site descriptions and summaries were consulted to obtain and verify the quantitative and qualitative data requested, including 1) the total number of sites reported in the reference, 2) the total number of agricultural sites, 3) the number of irrigated agricultural sites, 4) the number of non-irrigated agricultural sites, 5) field size, 6) agricultural features identified, and 7) any comments necessary to clarify the data. Historic sites were not included in the tabulations. These data were recorded by county and reference number, along with comments about data or source. Fifteen references could not be located, bringing the total number of references examined to 123. Totals appear by county for each category and for the whole state in Table 2-1. Multiple county references were listed under the county forming the largest portion of the study area if not broken down by county. A 300 page document resulted, which is on file at the SHPO for those interested in more specific information.

Data Limitations

The computer data inventory forms are inconsistent and incomplete in many cases. The lack of standards for extracting information for inclusion in the inventory has resulted, for example, in the classification of some field house structures under the category "habitation"; there are 589 inventory entries under "habitation" - each would have to be examined by hand to determine if the category had been applied to a field house rather than a different type of structure utilized for habitation. In cases where agricultural fields were associated with a hamlet or village, the fields have gone unrecognized in the database, and the site was classified as a hamlet or village. In other cases, hamlets, villages, pueblos and even mound sites that were dependant upon non-irrigated agriculture (due to locations that did not permit irrigation systems) have been classified as habitation sites, or under thematic categories including population aggregation. The inferential leap has not been consistently made between remains in the archaeological record that are indicative of any level of agriculture and the need to indicate that potential in the database. This results in a molding of information to fit categories in contrast to a database that will allow researchers to investigate a problem objectively.

There is no way to eliminate duplication of sites from the database other than to maintain a hand-written list of site numbers, which becomes cumbersome. In some reports, sites are not listed by site number, and in other reports, data are not quantified. Many reports do not list sites by types, and there is no consistent use of the required SHPO abstract which would allow an investigator to know how many sites were found and reported. For example, the Pima County inventory only lists the number of sites from a particular project, does not provide other data, and was useless for this project. The Maricopa County inventory uses vague site types; for example, it was unclear whether "rock alignments" included "check dams", and whether one-room habitations included "field houses."

Types and numbers of features and field size were not usually quantified. Occasionally, "agricultural" was the only descriptive term used, with no reference to fields, field houses, alignments, check dams or other agricultural features, making judgements concerning the presence or absence of irrigation questionable.

Summary of Spatial Distributions

To develop a sense of the spatial distribution of prehistoric non-irrigated agricultural sites, the reports containing relevant information were listed by county. It was determined that 13 of the 15 counties in Arizona have reported non-irrigated agricultural sites within their boundaries (Table 2-1). It is not surprising

TABLE 2-1.

Prehistoric Agricultural Sites in SHPO Database

County	Total # Sites	Ag. Sites	Irrigated Ag. Sites	Non-Irrig. Ag. Sites
Apache	161	2	0	2
Cochise*	3416	209	8	201
Coconino*	530	261	0	261
Gila*	659	222	0	222
Graham	40	5	0	5
Greenlee	0	0	0	0
La Paz	29	2	0	2
Maricopa*	3391	747	77	672
Mohave	21	1	0	1
Navajo*	699	72	0	72
Pima	1331	77	1	76
Pinal*	393	120	2	118
Santa Cruz	4	0	0	0
Yavapai*	167	63	2	62
Yuma	0	0	0	0
Totals	**10,841**	**1781**	**90**	**1694**

Notes:

1. * indicates counties which include multiple county reports.
2. **: 3 sites have an early non-irrigated agriculture component and a later irrigated agriculture component.
3. 1781 sites (16.4%) of 10,841 total sites are agricultural.
4. 90 sites (1%) of 10,841 total sites used irrigation agriculture; this is 5.1% of 1781 total agricultural sites.
5. 1694 sites (15.6%) of 10,841 total sites used non-irrigated agriculture; this is 95% of 1781 total agricultural sites.
6. Non-irrigated agriculture sites are 19 times as common as sites using irrigation agriculture.

that the western-most counties, (Yuma, La Paz, and Mohave) have reported few sites of interest, based upon the fact that western Arizona received the lowest amounts of rainfall and would predictably contain lower frequencies of non-irrigated agricultural sites (see Figure 2-3 for a map of the counties in Arizona). It is a historical fact that native peoples farmed along the Colorado River, but this type of flood plain farming leaves little or no archaeological evidence. It is surprising that only one report is listed for Santa Cruz County, as non-irrigated agricultural sites are common throughout the length of the river, and many have been recorded (Fish and others 1992; Masse 1979). An absence of reports on such sites in southeastern Arizona (Cochise and Greenlee counties) is undoubtedly a result of low field survey or reporting.

To provide quantitative data on actual site numbers, the reports were reviewed and basic data were recorded on relevant variables, including the number of sites reported, the number of agriculture-related sites present, and, when possible, the number of irrigated and non-irrigated agricultural sites present (Table 2-1). Sites appear to be generally distributed, and are present in some quantity within one-half of the counties. Agricultural sites represent 16.4 percent of the total site count, indicating that they are and will continue to be commonly encountered resources. The sample also indicates that non-irrigated agricultural sites are 19 times more common than irrigated agricultural sites.

This search has produced one clear fact: non-irrigated agricultural sites were common elements of the prehistoric landscape throughout most of Arizona. They therefore represent a large, geographically dispersed, culturally variable, and highly significant resource base that must be properly managed.

Literature Search

A literature search was conducted as another strategy to obtain information on the distribution of prehistoric non-irrigated agricultural sites in Arizona. Most information sources are in the "grey literature," and are represented by limited copies of archaeological reports printed during the past 15 years. The search did produce useful information while pointing out some difficulties associated with such a study. Many reports do not contain basic site data (site counts by site type), while others use ambiguous terms, such as "limited activity" or "artifact scatter," sites, some of which could be agriculture-related.

The Wupatki survey strikingly reveals a major problem in estimating the number of prehistoric non-irrigated agricultural sites in Arizona. Of the total of 2,397 prehistoric sites, only 68 actual "fields" were recorded, which were indicated by the presence of field features. A significant aspect of the field methodology was that only "isolated" field sites were recorded as "fields", while other fields were recorded as components of other sites (Travis

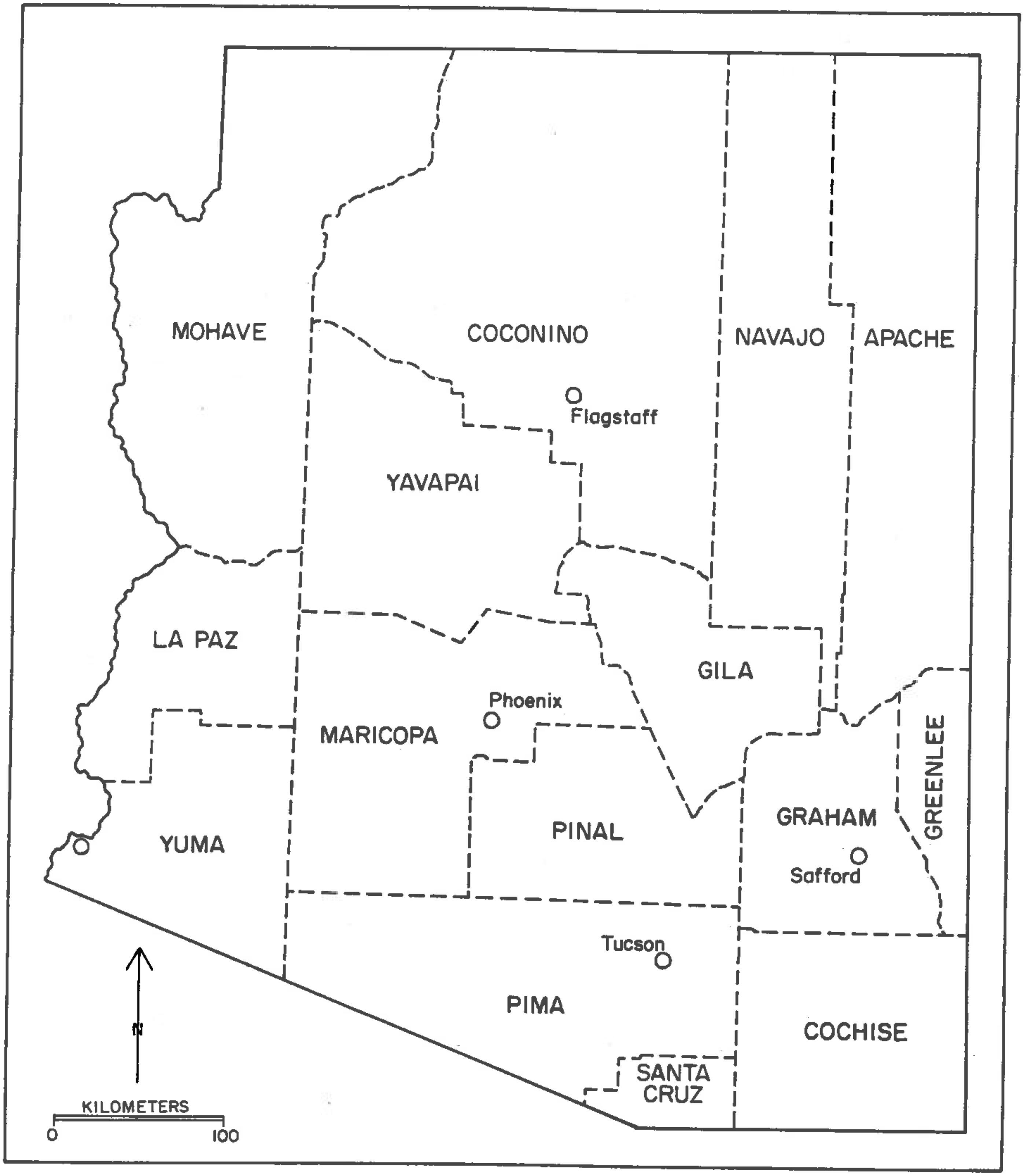


Figure 2-3. Modern Geo-Political Subdivisions in Arizona.

1990). By way of contrast, 1,456 "field houses" (61% of the total number of sites) that are thought to be directly related to non-irrigated agriculture were recorded, which provides a more definitive indication of the importance of agriculture than does the number of "fields" recorded separately. This masking of the real occurrence of non-irrigated field sites is not unique to this project (see Fuller, Rogge and Gregonis 1976:74, for example). Coupled with the common lack of visibility of field sites and the lack of training among archaeologists to recognize such sites, it is probable that prehistoric non-irrigated agricultural sites in Arizona are dramatically under-reported.

CHAPTER 3

PROPERTY TYPES AND METHODS OF STUDY

This chapter provides discussions of the property types, features, and artifacts associated with prehistoric non-irrigated agriculture in Arizona. Methods used to identify and study non-irrigated agricultural sites are identified.

Property Type Descriptions

A **property** is a district, site, building, structure, or object, while a **property type** is a grouping of properties based on a set of shared characteristics (National Park Service 1986:8). Property types associated with prehistoric non-irrigated agriculture in Arizona include fields, field features and field systems, and associated features, such as field houses, farmsteads, limited activity, and special function properties.

Fields

Non-irrigated agricultural field sites vary greatly in size, shape, location, and content. Fields in southern Arizona range from simple cleared areas to extensive systems containing hundreds of features distributed across many acres. Small and large fields appear to have been farmed simultaneously using a diversity of strategies. Cleared fields utilized for runoff agriculture located along the Salt-Gila Aqueduct on the east side of the Phoenix Basin ranged between 1 and 1,500 m^2 (Crown 1984b:246). Along the Gila River near the Santan Mountains, an extensive field area containing rock piles, rock alignments, and artifacts was traced for 1 km and varied in width from 200 to 900 meters; this site could not have been irrigated by canals and runoff must be suspected (Dart 1983:433). The Marana community contained over 485 hectares (two square miles) of rock pile fields that contained smaller fields ranging in size from 10 hectares (25 acres) to 50 hectares (125 acres) (Fish and others 1992:78). Historic O'odham fields ranged between two and four hectares (5-10 acres), but fields smaller than one hectare and larger than 17 hectares have been reported (Gasser 1990:21). Prehistoric Hohokam fields also seem to show this range of variation.

In the mountains, fields may occur in a variety of situations, including in or near meadows, arroyos, or small drainages. A diversity of situations also exists on the Colorado Plateau: fields could be small or large and located in sand dunes, along the edges of small drainages, on alluvial flats, or in broad floodplains. Fields at Wupatki ranged between one acre and ten acres in area, and were distributed on slopes ranging from five to fifteen degrees (Travis 1990:22-25). Stone-enclosed terrace gardens at Wupatki were the size of contemporary Hopi gardens, usually less than 100 m^2. One difficulty in assessing non-irrigated agriculture, especially in the mountain and plateau provinces, is the knowledge that many fields were not enhanced with fixed features that have survived to the present, thus rendering field identification difficult at best.

Research by Hack (1942) and Winter (1978) on Hopi agriculture has described a complex array of non-irrigated farming strategies utilized in the arid landscapes of northern Arizona (Table 3-1). Hopi agriculture is an example of a strategy of diversification as insurance against local crop failures. Numerous dams, ditches, terraces, and other features are scattered across the landscape. Planting dates are staggered to further insure success against the vagaries of climate.

An important point to make here is that of the ten field types identified in Table 3-1, only check dams in arroyo bottoms or terraces have associated features made of stone that might survive in the archaeological record (Winter 1978:86). Because of the general reliance on alluvial and dune farming, recognition of prehistoric fields is a serious problem on the Colorado Plateau, and usually must rely on associated archaeological remains. Similar situations also exist in southern and central Arizona. Crown (1984a:44) describes a small Hohokam hamlet that seemed to be based on agriculture; it is assumed that floodwater farming was practiced in a large field located one kilometer from the hamlet. Doyel (1977) has described farmsteads located on gravel terraces to the north of Nogales, where it is presumed that farming occurred in nearby arroyos and/or the floodplain of the Santa Cruz River.

Visibility of non-irrigated agricultural fields is often directly dependent on the type of farming practiced. Table 3-2 lists the major types of agricultural strategies known for Arizona. It is apparent that three of the four strategies would not produce materials consistently visible in the archaeological record. It becomes ever more clear that prehistoric non-irrigated agricultural field sites have a greater likelihood of being identified through their association with other archaeological materials, such as field systems and associated property types.

To pursue this line of investigation, respondents to the project questionnaire were asked to identify both direct and indirect evidence for non-irrigation agriculture (Table 3-3). Ninety-two percent responded that the presence of field features was the best direct indicator of non-irrigation agriculture. Proximity to agricultural soils and the presence of field houses were also common responses. The most common response in the indirect category was the presence of botanical remains, a class of data usually only available through excavation. Associations with artifacts and certain types of features (roasting pits) were also identified as evidence suggestive of agriculture.

TABLE 3-1.

Hopi Field Types

Field Type	Associated Strategies
Floodwater fields	
Ak chin	Summer storm runoff
Wash floodplains	Alluvial fan locations
Low terraces	Seepage, springs or runoff
Arroyo bottoms	Small drainages
Slope wash	Runoff from higher elevations
Sand dune fields	Various topographic situations
Seepage fields	Below seeps in mesas and wet dunes
Springside fields	Often on hillsides in alluvial soils
Stream-side fields	Located in Moencopi canyon
Dry Fields	Higher elevations with more rainfall

TABLE 3-2.

Visibility of Non-Irrigated Agricultural Features

Agricultural strategy	Expectations
Floodplain	
Inundation	Low visibility
Ak chin	Low-moderate visibility
Runoff	High visibility
Dry Farming	Low visibility

TABLE 3-3.

Evidence Supportive of Non-Irrigated Agriculture

Presence of field features.
Proximity to agricultural soils.
Presence of field houses.
Evidence of cleared fields.
Observed differences in vegetation.
Presence of specific artifact types, such as stone hoes.
Presence of botanical remains in associated features.
Associations between cultural materials and arable land.
Associations of sites (field houses) with arable land.
Presence of features, such as roasting and storage pits.
Presence of charcoal in field areas.
Presence of sherds in fields suggesting pot irrigation.
Presence of features difficult to interpret as other than related to agriculture, i.e., isolated stones in "arable" land.

Field Features and Field Systems

A diversity of feature types and field systems are associated with prehistoric non-irrigated agriculture in Arizona. Vivian (1974) defined an <u>agricultural feature</u> as any landscape modification that functions to control water, soil erosion, or both. Additional functions might include boundary delineation to define ownership or to differentiate crops. An <u>agricultural system</u> is defined as a set or combinations of features. Associated structures, such as field houses, may be part of an agricultural system but are normally not considered to be agricultural features (Cordell 1984:189).

In a systematic survey of the field systems located on Tumamoc Hill near Tucson, Masse (1979) defined a number of features that are now recognized as characteristic of Hohokam agricultural fields. These include rock piles, contour terraces, check dams, bordered gardens, and channeling borders (Figure 3-1). For more information on non-irrigated agricultural features in the desert region, see Ayres (1967), Canouts (1975), Crown (1984), Debowski and others (1976), Fish and others (1992), Masse (1979, 1991) and Rankin (1989).

Rock piles are the most common type of feature in agricultural fields in southern and eastern Arizona (Figure 3-2). They are found on gravel terraces above rivers, on gently sloping plains (bajadas) and in alluvial situations along drainages (Doyel and Elson 1985; Fish and others 1992; Masse 1979; Rankin 1989). They commonly occur on slopes with less than five percent grade. These features are groups of unmodified cobbles between 10 and 40 cm in diameter that have been collected and deposited into piles. They rarely exceed 0.75 cm in height or 1.5 m in length, and are often smaller. They may be flat but are usually dome-shaped in cross-section. Some excavated examples have mounded earth located beneath layers of stones.

Rock piles are usually spaced several m or more apart, and may be found alone or in combination with other types of features, such as linear borders, rock alignments, roasting pits, and other cultural features (Figure 3-3). Groups of such features are commonly called "rock pile fields". Over 1,000 rock piles were observed in the Tumamoc Hill site (Masse 1979:164). In the Marana community, it is estimated that 42,000 rock piles were developed, along with 120,000 m of stone alignments; in total, 50 person-years (one person working for fifty years, or 10 people working for five years) were invested in the construction of the facilities (Fish and others 1992:85). Extensive rock pile fields exist along the Agua Fria, Verde, Salt, Gila, and San Pedro Rivers, in the Tonto Basin area, and in southeastern Arizona. Omar Turney estimated that 4,000 hectares (10,000 acres) of non-irrigated field systems were present in the Salt River Valley (Turney 1924). Rock piles have also been found in northern Arizona at Wupatki (Travis 1990).

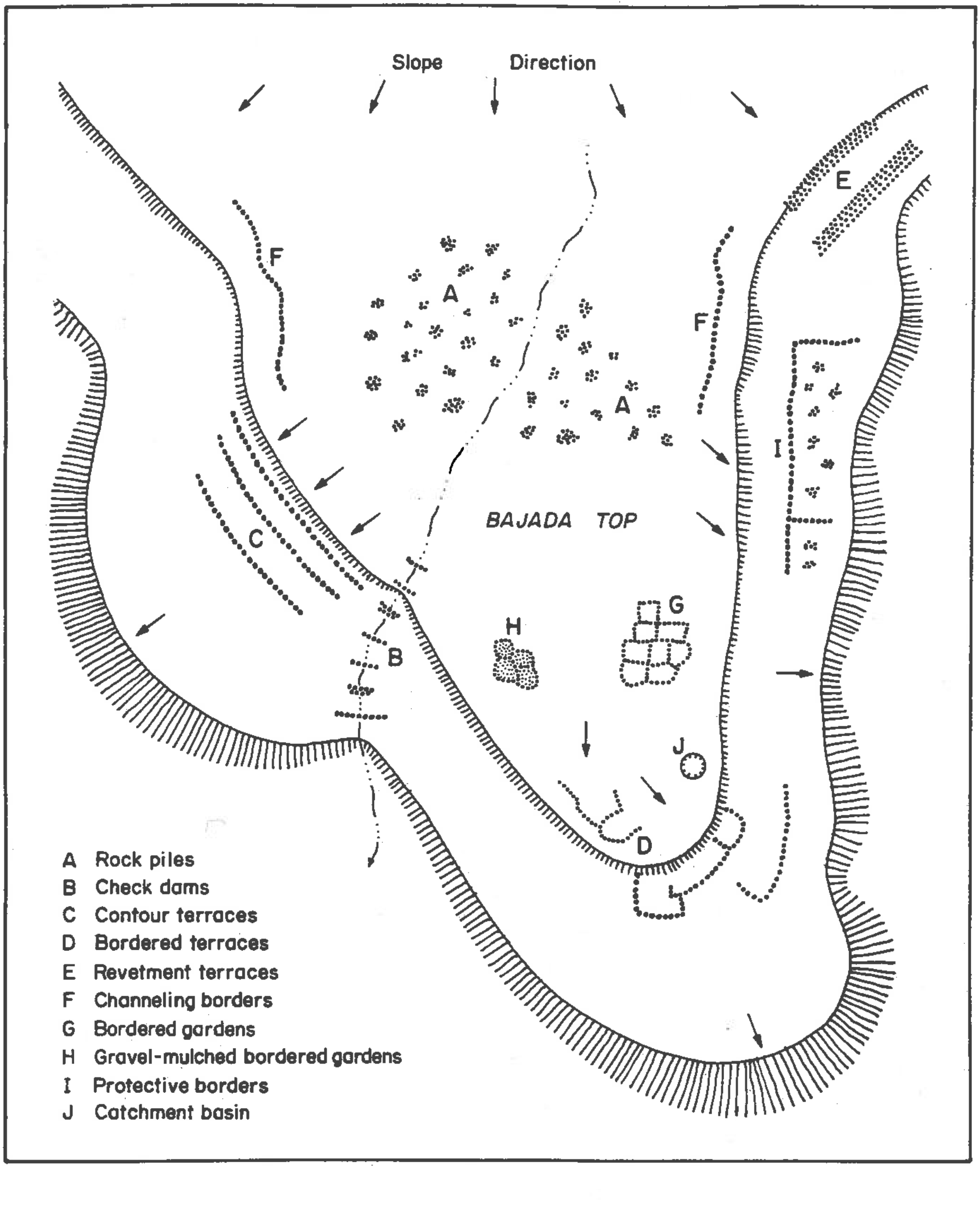


Figure 3-1. Runoff Farming Features. Adapted from Masse, 1991.

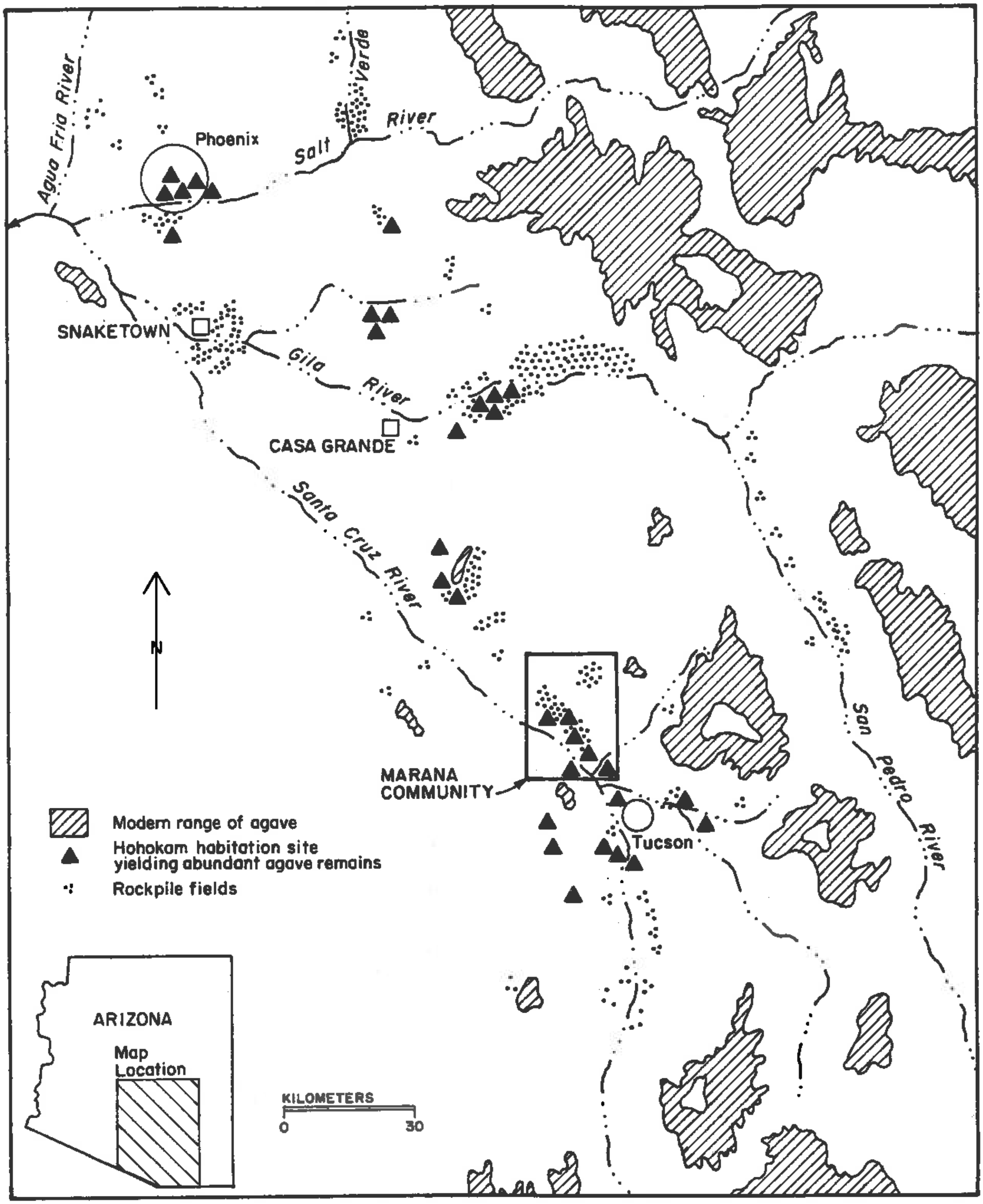


Figure 3-2. Distribution of Rock Piles in Southern Arizona. Adapted from Fish and others, 1992.

Rock piles represent several discrete functions. One is the simple removal of stones from field areas (Doyel and Elson 1985). In some cases, rocks may actually have been carried for some distance to create or construct rock piles, while in other cases rock piles do not appear to be directly associated with cleared areas (Crown 1984:256). In these instances rock piles may have served as moisture retaining devices for the cultivation of agave and possibly cholla, while other crops may have been planted in the adjacent cleared areas (Fish and others 1992; Masse 1981; Rogers 1978). Rock pile mounds provide a sheltered environment for the roots of the plants and also serve to retain moisture which accelerates growth. In contrast to other parts of the world where similar features are found, such as the Negev Desert (Evenari and others 1971), rock piles in Arizona were not the result of slope clearing to increase surface runoff to adjacent fields. Rock pile systems were common in the desert region between A.D. 900 and 1050 (Masse 1991:211); increased use of rock piles as agricultural mounds appears best dated to between A.D. 1100 and 1300, but such features may also date to earlier periods.

Non-irrigated agricultural features, including check dams, contour terraces, rock alignments, and rock piles are common in the basins, mesas, and mountains in central Arizona (Macnider and Effland 1989; Woodbury 1961). Over 80 ha of waffle gardens, check dams, linear borders and rock piles have been recorded near Sacred Mountain (Fish and Fish 1984:150). Extensive field systems exist in the Tonto Basin (Wood and McAllister 1984). Systems in the Central Mountain basins remain unrecorded, and some have been lost to reservoir inundation (Fuller, Rogge and Gregonis 1976:74). Gridded gardens are present near Phoenix (Turney 1924), while large gridded field systems have been reported from the Gila River areas in east-central Arizona (Woosley 1980).

A variety of field features and systems were recorded at Wupatki in northern Arizona (Figure 3-4). Seven field types reflect increased levels of landscape modification, including (1) simple fields (2) rock pile fields, (3) bordered fields, (4) bordered gardens, (5) composite fields, (6) terrace gardens, and (7) terrace fields (Travis 1990:13). Field types that have left no evidence through landscape modification include cinder berm and simple floodwater fields. Eight feature types were found in association with these fields, including (1) rock piles, (2) rock pads, (3) rock semicircles, (4) rock alignments, (5) terrace walls, (6) check dams, (7) cinder berms, and (8) upright stones (Travis 1990:10).

Unlike southern Arizona, where rock pile function seems to fall within a narrow range, rock piles in the Wupatki fields may have functioned in a variety of ways, including (1) to serve as field boundary markers, (2) to stabilize erosion, (3) to provide support for scarecrows, (4) to protect plants from damage, (5) to construct field shrines, or (6) as the result of field clearing. Rock piles in a single field could theoretically have served all of these

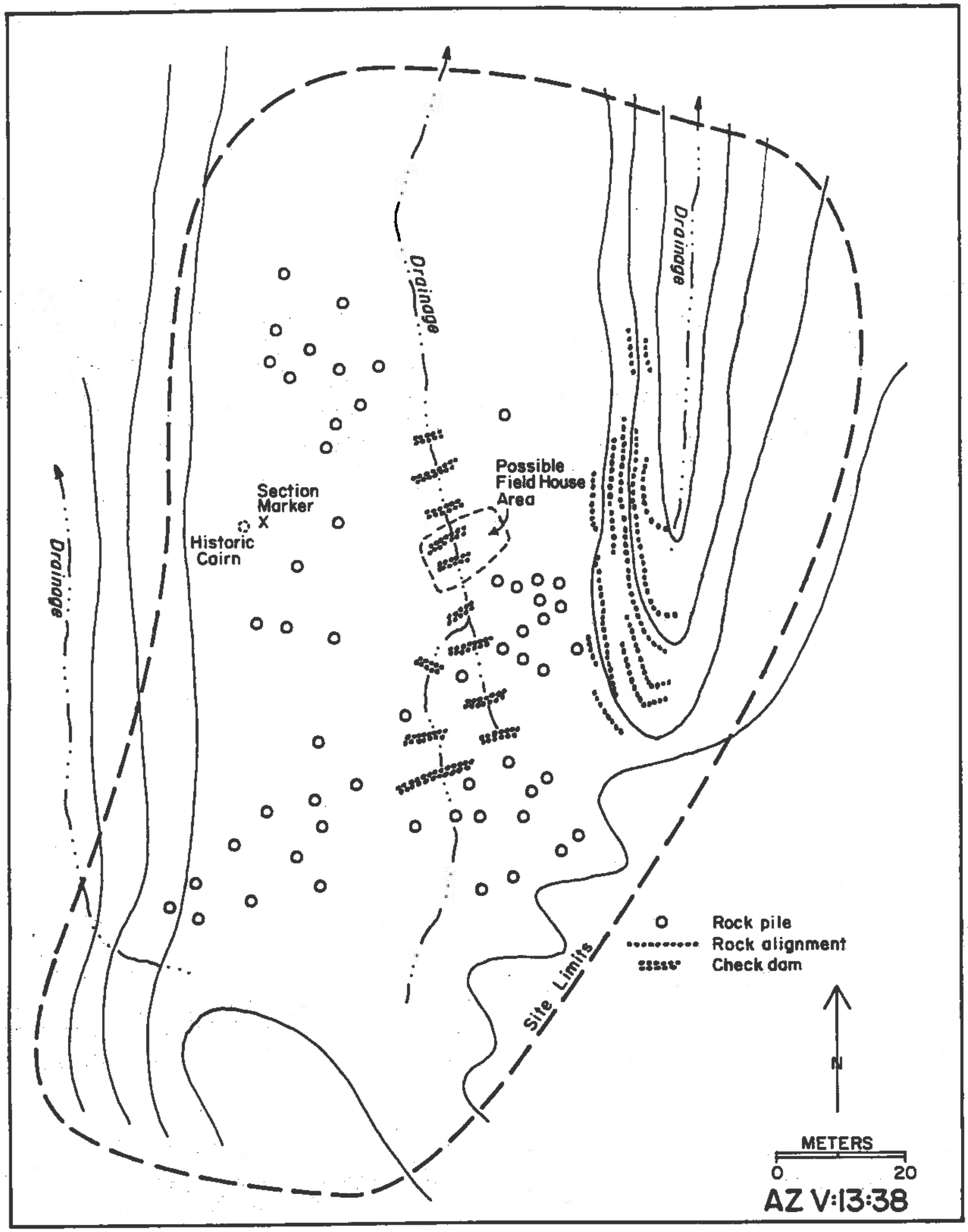
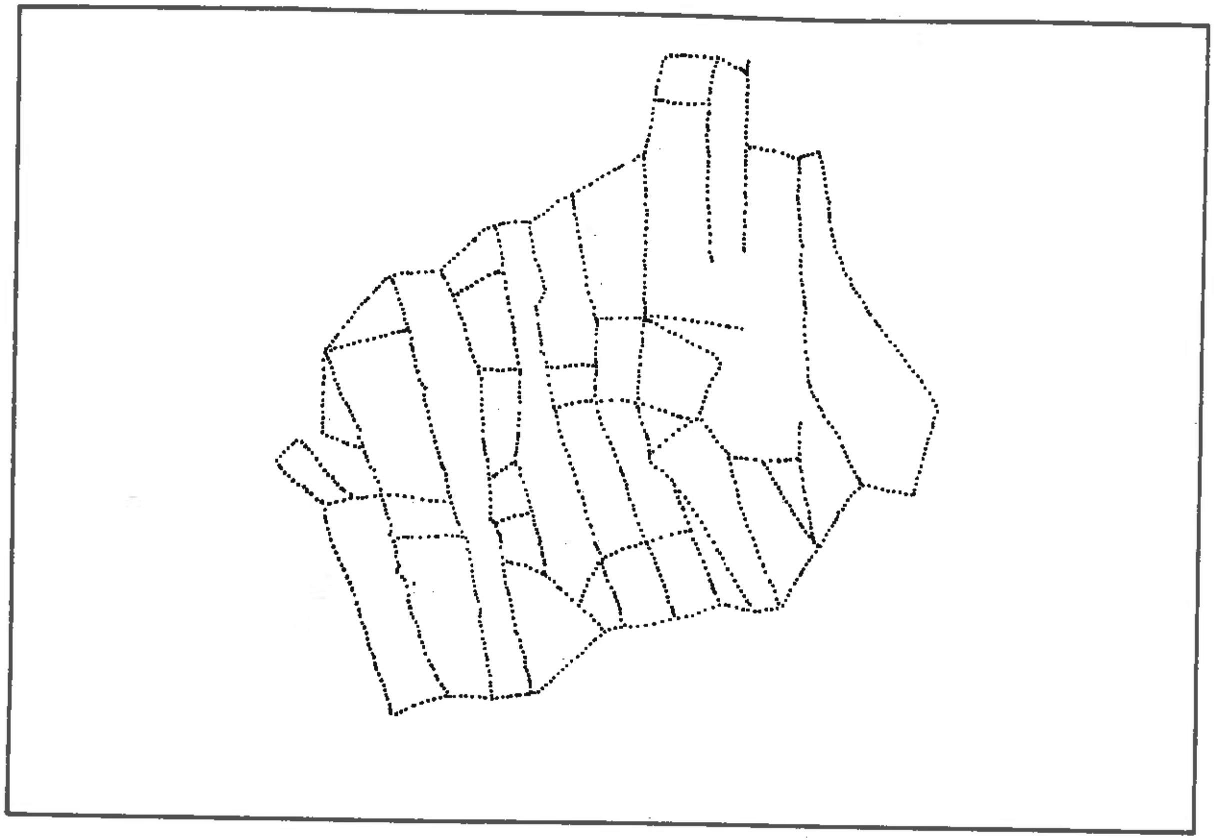


Figure 3-3. Rock Pile Fields in the Buttes Area, Gila River. Adapted from Debowski and others, 1976.



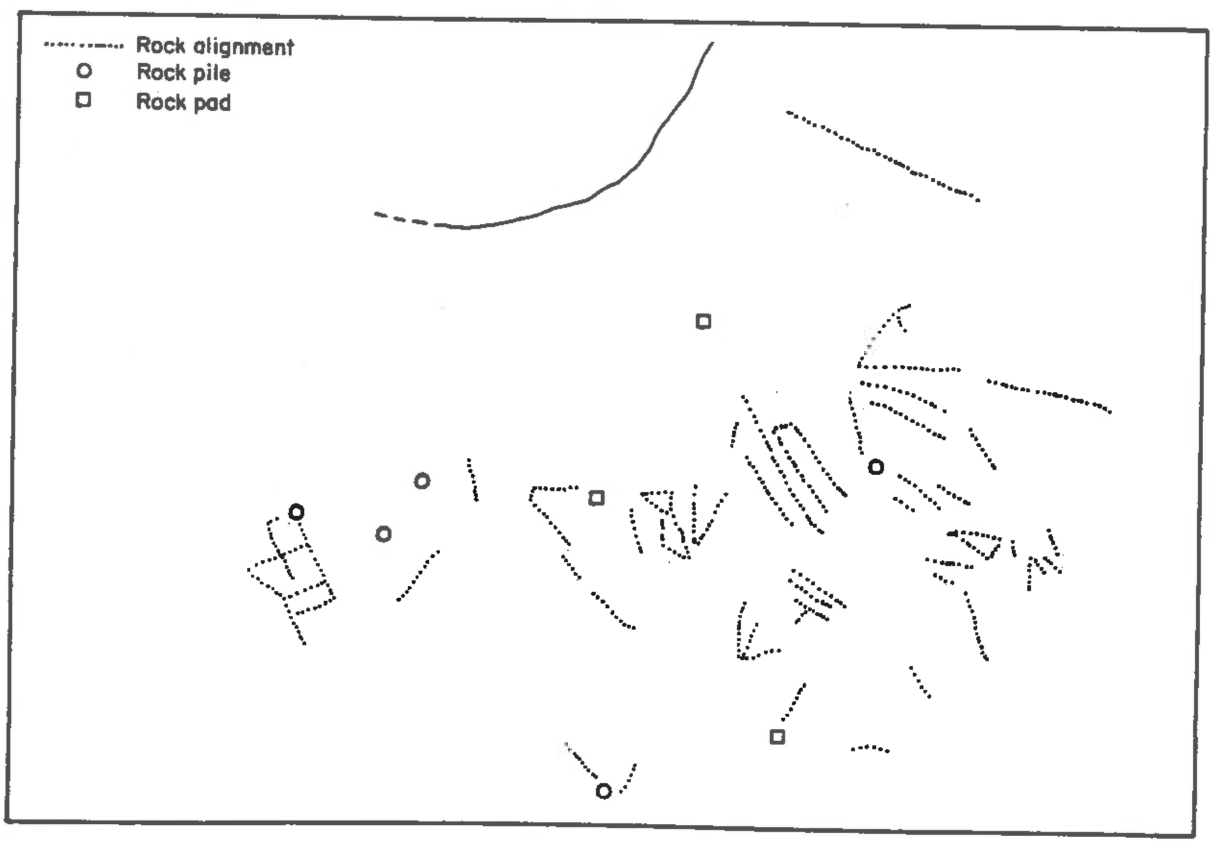


Figure 3-4. Field Systems at Wupatki. Adapted from Travis, 1990.

functions while looking much the same. Use of rock piles for moisture retention or as planting beds is not identified (Travis 1990:10). In general, rock piles are not common elements of agricultural fields in the Pueblo area, perhaps because farming in most areas was (and is) conducted in alluvial situations that lack rock on the surface.

A general class of features, referred to as "rock alignments", are the most common elements found in Wupatki field systems. They exhibit a variety of stone material types, shapes, sizes, and construction styles, and range in length from under 1 m to over 100 m (Travis 1990:11). They occur in parallel rows, as contour alignments on slopes, as grid patterns, or other shapes, while their density can range from several to several hundred within field areas. Most of these features functioned to control erosion, to conserve soil, and to direct the flow of water across fields (Forde 1931; Plog and Garrett 1972; Winter 1978).

Some terraces were constructed to collect soil to create spaces behind which to plant crops (Travis 1990; Woodbury 1961). Terraces are constructed of masonry, can be one or two courses in width, and are usually under one m in height (Hack 1942:37). Check dams are similar features that were built on slopes or in arroyos to trap soil and to impede the flow of water (Winter 1978:89; Woodbury 1961). Such features may also have been constructed to control slope wash to protect down slope fields (Doolittle 1985).

A rare field type at Wupatki is composed of cinder berms laid out in a grid-like pattern. This field type, which may have low archaeological visibility, would have provided soil and water conservation in flat, exposed areas characterized by low rainfall and high winds (Travis 1990:12).

Regional Diversity in Non-Irrigated Agriculture

Regional variation in non-irrigated agriculture from north to south is documented in the archaeological and ethnographic literature of Arizona. This diversity is reflected in the responses received from archaeologists working throughout the state (Table 3-4). The most common terms used by those working on the plateau were "sand dune," "terrace," and "ak chin," while the most common terms used by those working in the south (below the Mogollon Rim) were "ak chin," "rock pile," and "runoff." Those in the north thought proximity to good soils and the presence of field houses were strong evidence for non-irrigated agriculture, while those working in the south most commonly cited the presence of field features.

Hohokam agricultural field sites exhibit a variety of features made of stone and presumably brush, including rock piles, check dams, gravel mulched gardens, field borders, terraces, ditches, and

TABLE 3-4.

Commonly Found Field Features and Farming Strategies

ak chin*	arroyo bottom
check dam	cleared field
ditch	diversion
dry farming	floodwater*
gravel mulch	gridded (waffle) garden
ground water	overbank flooding
pot irrigation	raised gardens
runoff*	rock pile*
sand dune*	soil mounds
terrace gardens*	trinchera

* most common responses statewide

reservoirs. Like other regions in Arizona, associated features include roasting pits, field houses, farmsteads, and storage structures (Masse 1991; Rankin 1989).

A wide range of water-control technology has been reported from the Central Mountains, including rock piles, check dams, terraces, linear alignments, rock spreaders (diversion features), dams, dikes, and wells (Accola 1981; Peterson 1988; Tuggle, Reid and Cole 1984; Woodbury 1961). In the western areas, emphasis appears to have been on controlling runoff, while in the east there may have been more emphasis on ground water or alluvial farming strategies.

Stone terraces, check dams, linear borders, gridded fields, mulched gardens, ditches, dams, and reservoirs are associated with fields on the plateau, and rock piles have been reported from the Wupatki area (Travis 1990; Winter 1978; Vivian 1990).

Redundancy in form and function in field features across Arizona is expected because of the basic engineering principles involved in prehistoric agriculture. Obvious differences reside in matters of emphasis, system scale, and the intensity of use. Topographic and hydrological factors likely account for much of the variation in non-irrigated strategies throughout the state.

Associated Property Types

Settlements

Most prehistoric agricultural groups had a variety of settlement types, including villages, hamlets, farmsteads, and field houses. Non-irrigated agricultural features may be associated with each level of this settlement hierarchy. Villages and hamlets were occupied throughout the year. Villages had larger populations and contained public architectural features that served surrounding populations, such as plazas, storage facilities, meeting lodges, ball courts and great kivas (Gregory 1991; Vivian 1990). The larger villages most likely served as regional market places where agricultural produce and other commodities were exchanged.

Farmsteads

This settlement type was established primarily for agriculture and related purposes. Farmsteads may have been occupied seasonally, perhaps on a repeated basis, and some may have been the permanent residences of small groups who maintained ties with the larger settlements (Figure 3-5). Ceremonial features are usually not found at farmstead sites. Due to extended occupations at these sites, architectural features may be substantial and may be associated with outdoor features including hearths, roasting and storage pits, processing areas, and burials, as well as localized trash and occupational debris (Crown 1983; Doyel and Elson 1985).

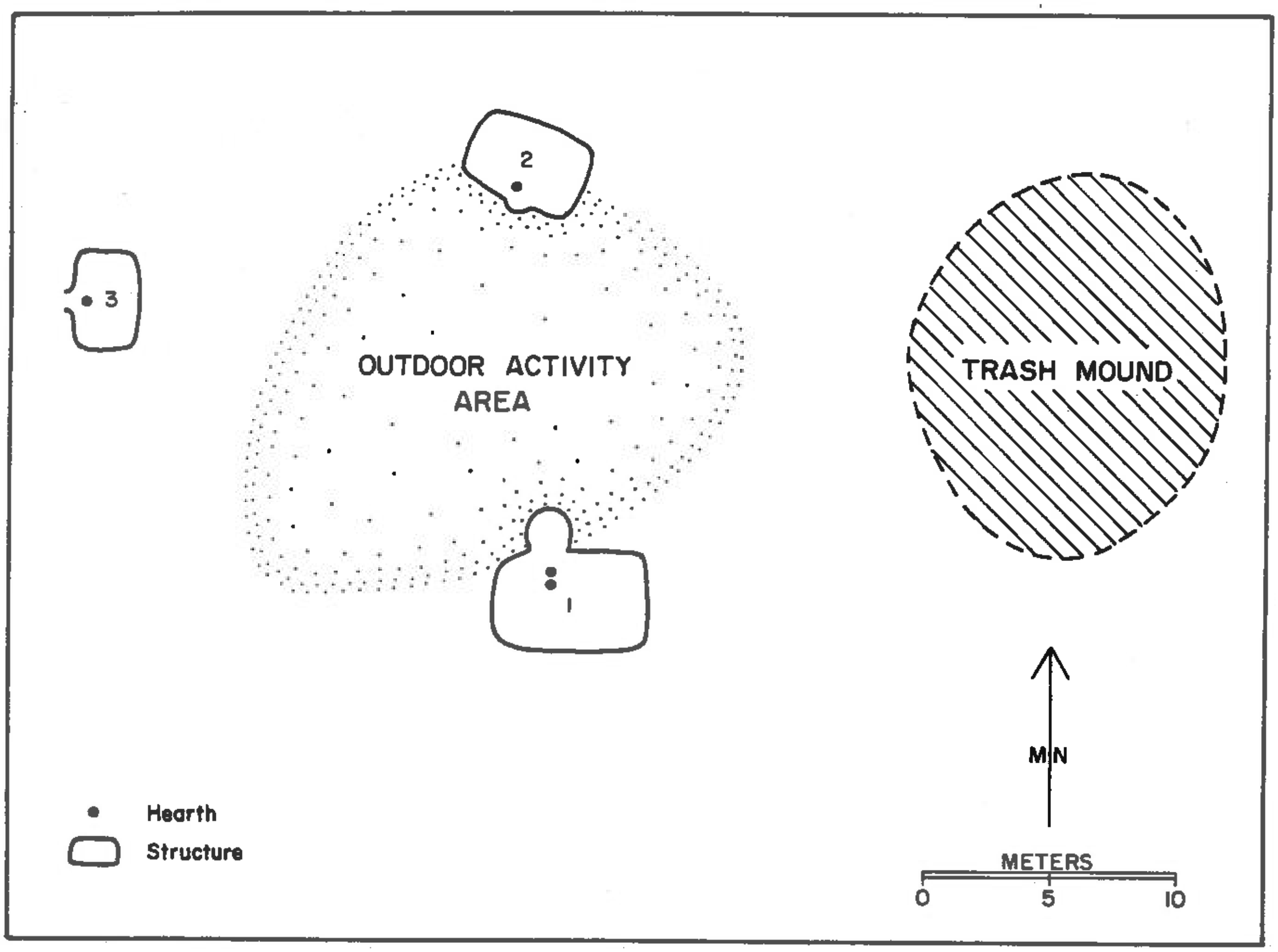


Figure 3-5. A Hohokam Farmstead Along Queen Creek.
Adapted from Teague and Crown, 1983.

Field Houses

Field houses are represented by one or more structures established for the purpose of tending agricultural fields. Numerous examples of prehistoric field houses have been excavated and reported (Crown 1983; Doyel and Elson 1985; Green 1989; Gregory 1991; Ward 1978; Wilcox 1978). These sites contain ephemeral architectural features with little associated trash, and the diversity of artifacts and botanical remains tends to be low. Field houses in the Hohokam area exhibit a range of size, shape, and architectural style, from small, oval-shaped pit houses to cobble-outlined rooms. They are usually not associated with large numbers of features and artifacts. Field houses as a property type may represent the most common prehistoric settlement type found in Arizona, and their presence may be indicative of nearby fields (Figure 3-6). Caution must be taken, however, to insure that other activities, such as pinon nut or acorn gathering, cannot account for the presence of "field houses" in some localities. At Wupatki, field houses, usually made of stone, were present at 60 percent of the 2,400 sites reported (Figure 3-7), indicating that these features, and presumably their associated agricultural fields, comprised a significant portion of the prehistoric landscape (Anderson 1990). Puebloan people continued to use a variety of field house structures into the historic period (Cushing 1920; Forde 1931).

Windbreaks

Mindeleff (1989:217) noted that "Lightly constructed shelters for the use of those in charge of fields were probably a constant accompaniment of Pueblo horticulture. Such shelters were built of stone or brush, according to which material was most available." (Figure 3-8). Crude alignments made of several courses of stone, usually 1.5 to 3 m in diameter, and located in or near fields are often interpreted as windbreak shelters (Woodbury 1961:14). Such shelters may or may not have had brush roofs associated with them.

Prehistoric ramada features and single-wall structures with associated fire-boxes have been excavated in the upper Little Colorado River Valley (Doyel and Debowski 1980). Based on the architecture, these sites were occupied repeatedly, probably on a seasonal basis (Figure 3-9). Associated locational, botanical, and artifactual remains provide evidence for sand dune farming.

Storage Facilities

Some field houses served as facilities to store tools and harvested crops. Isolated structures near fields that appear to be storage structures have been found in central Arizona (Doyel and Macnider 1991; Effland and Macnider 1989). Small pit houses dating to the prehistoric period in the Phoenix area ranged from two to ten m^2 in floor area and appear to have functioned as field houses and temporary storage facilities (Cable and Doyel 1985; Crown 1985).

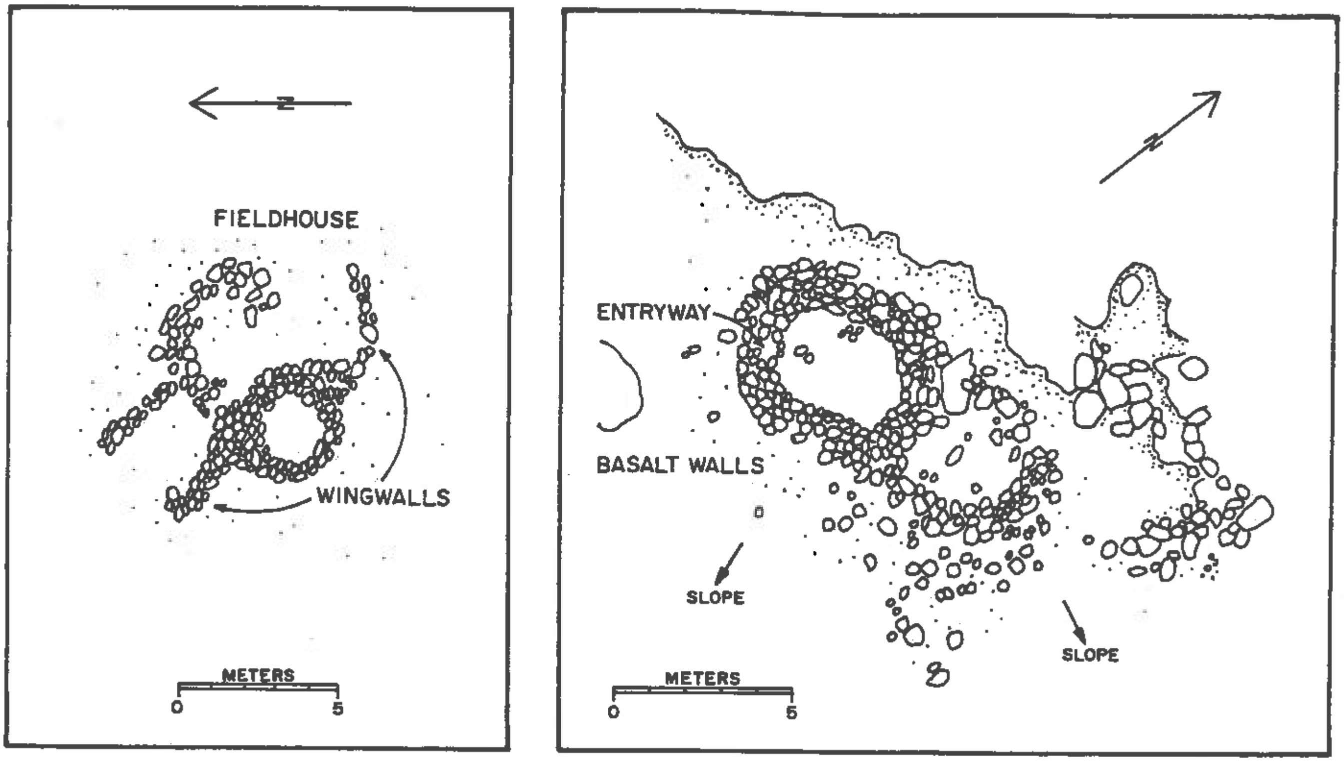


Figure 3-6. Field Houses at Wupatki. Adapted from Anderson, 1990.

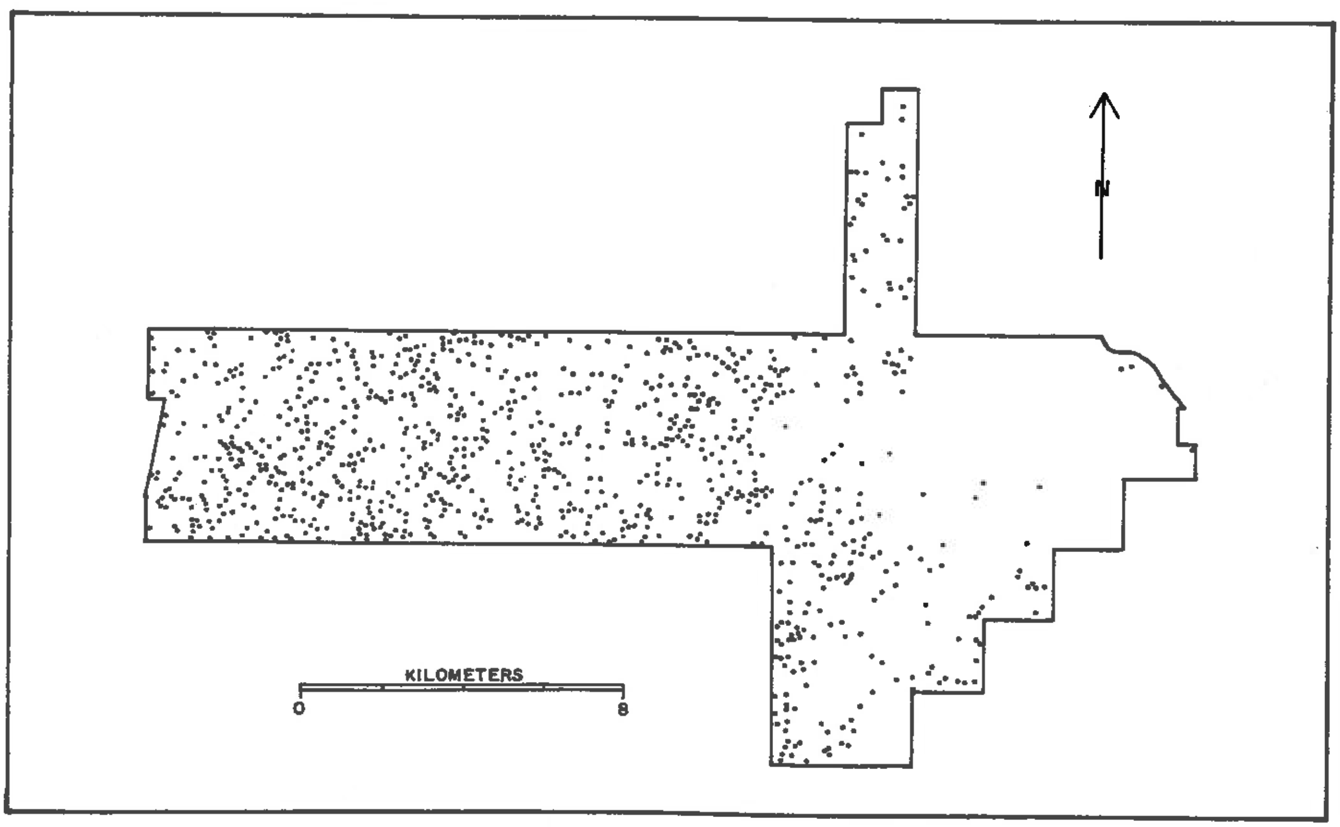


Figure 3-7. Distribution of Field Houses at Wupatki. Adapted from Anderson, 1990.

Processing Facilities

Other features found associated with non-irrigated agricultural sites may or may not be directly related to farming but are related to activities conducted nearby. Travis (1990:4-10) describes small, single course "rock pads" associated with fields at Wupatki that may have been used as processing stations. Bedrock grinding stations are present in or near field locations in multiple localities in Arizona (Doyel and Elson 1985). Masse (1979:151) describes the common association of "processing sites" with the extensive agricultural features along Tumamoc Hill in Tucson.

Rock rings are simple arrangements of stones, fist-size or larger, that were placed single-course high in the shape of circles of less than 40 cm in diameter. These features were used to hold baskets, pottery vessels, or other objects during collecting and processing activities (Doyel and Elson 1985). Given their generalized functions, rock rings may be found in association with a variety of property types, including irrigated and non-irrigated agricultural sites as well as native resource gathering and processing sites.

Large cooking ovens, also known as "roasting pits" or by the Spanish name "hornos", may be found in association with non-irrigated sites, especially when the focus was on growing and processing agave (Fish and others 1992). Such ovens may have been used to bake cactus fruits and other food items (Howard 1988). In the Pueblo area, pit ovens were commonly used to roast green corn harvested from the fields (Beaglehole 1937; Cushing 1920).

Limited Activity Sites

Another related property type is the ubiquitous "artifact scatter," "sherd and lithic scatter" or "limited activity site" found throughout Arizona (Doyel and Elson 1985; Effland and Macnider 1989; Teague and Crown 1983; Ward 1978). While many are related to resource procurement and processing activities that focused on native resources such as mesquite beans or pinon nuts, other sites are related to agricultural activities.

Reservoirs and Catchments

Available water was limited in many areas of the Southwest. In order to insure an adequate supply, both natural and artificial water storage facilities were utilized. Natural tanks holding runoff and spring water were used (Woosley 1980). Reservoirs of various sizes were constructed for storage in many areas including the desert, mountains and the plateau (Bayman and Fish 1992; Crown 1987; Masse 1991; Raab 1975; Vivian 1992). Reservoirs are usually associated with residential sites, where water use was divided between domestic activities and farming (Bayman 1992). Catchment facilities that may have been constructed for agricultural purposes have also been documented (Masse 1991).

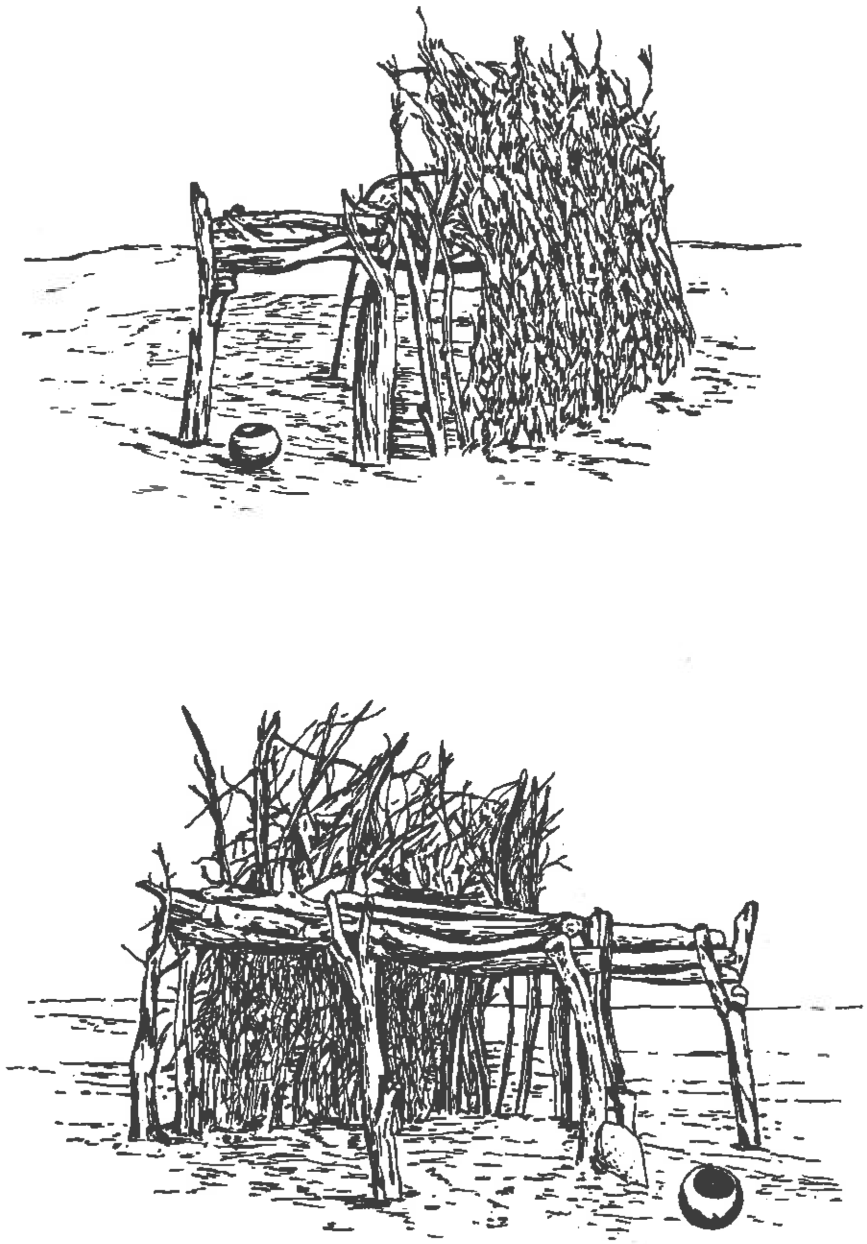


Figure 3-8. Historic Field Shelters in the Pueblo Area.
Adapted from Mindeleff, 1989.

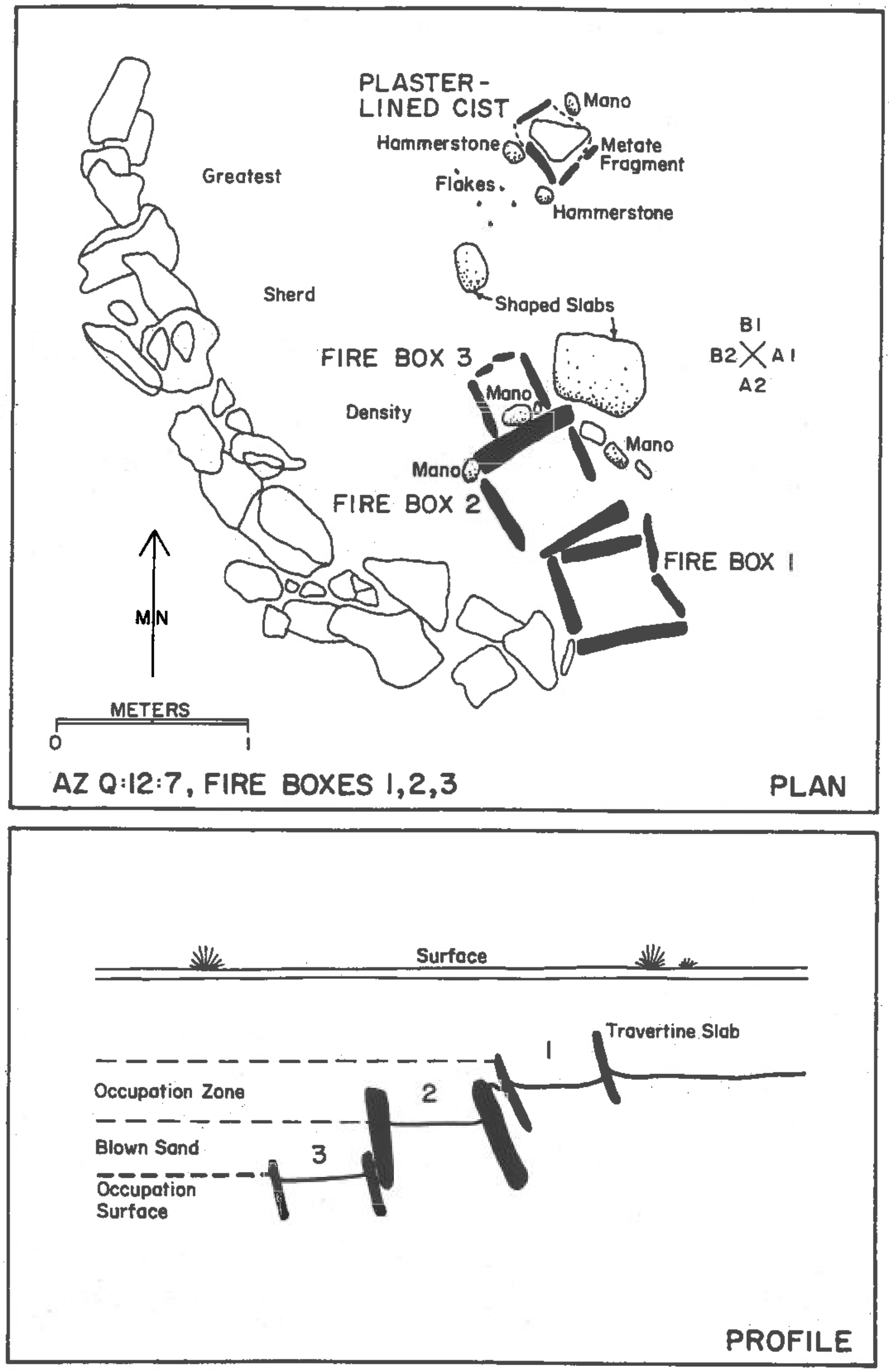


Figure 3-9. A Windbreak Shelter in the Little Colorado Valley.
Adapted from Doyel and Debowski, 1980.

Ritual Features

The Hopi built small stone structures in or near fields that were used for ritual smoking and to pray for rain (Beaglehole 1937:39). Shrines were common in Zuni fields, where rituals were performed to pray for rain and for good harvests (Figure 3-10) (Cushing 1920; Ferguson and Hart 1985). Shrines may also take the form of simple rock piles nearby or within field areas (Russell 1975).

Material Culture Correlates

Fish and others (1992:84) indicate that tabular knives made of stone (also known as "mescal knives" or "agave knives") and large chipped stone "pulping planes" represent 54 percent of the retouched tools in fields at Marana (Figure 3-11). The presence of agave knives and pulping planes, along with roasting pits and rock piles, strongly suggests agave cultivation. Pulping planes are common at sites in southern Arizona, but have been referred to by other names, such as "scraper planes" and "cores" (Debowski and others 1976; Doyel 1974; Green 1989). Ground stone tools- manos and metates- are common at agricultural sites where corn was grown and processed.

Given the appropriate environmental and depositional context, sherd and lithic sites might be indicative of prehistoric fields (Gilpin 1988; Lindauer 1984; Masse 1979:154). Large sherds might be used to water individual plants, to excavate watering basins, or as tools to process plant materials. Breakage could leave sherd scatters as field signatures. Alternatively, broken vessels may simply represent drinking water containers broken near work areas.

Methods of Study

Environmental analysis often provides critical tests for the identification of non-irrigated agriculture. A variety of techniques and data are utilized for such analysis.

Vegetation and Soil Patterns

Prehistoric fields have been inferred on the basis of vegetation differences. Fields along the Salt-Gila aqueduct were recognized by the presence of field features such as canals and stone features, but some were identified as "barren areas" associated with artifact scatters (Crown 1984b:246). Vegetation density and soil color have been used to infer prehistoric fields along New River, where irrigated fields contained less dense vegetation than surrounding areas, but the reasons for this pattern were not identified (Doyel and Elson 1985). Geomorphological analysis can provide information essential for evaluating the agricultural potential of field areas (Schuster 1990; Waters and Field 1986).

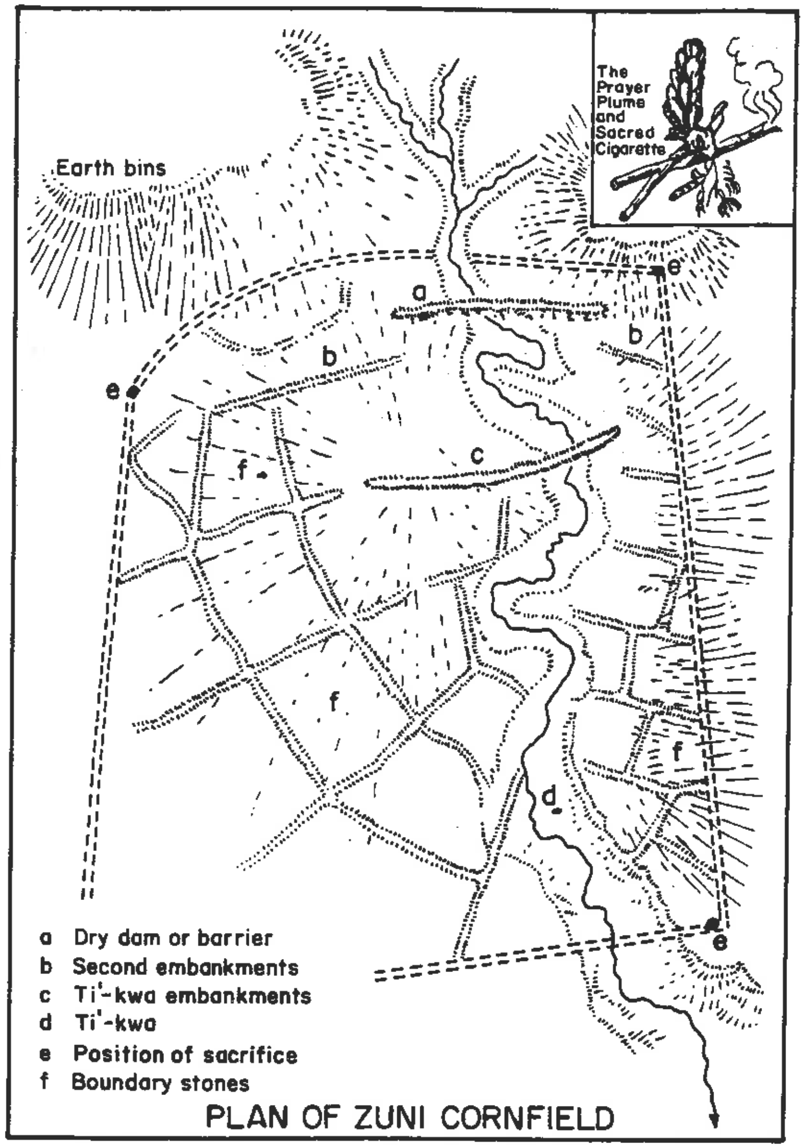


Figure 3-10. Plan of a Zuni Cornfield.
Adapted from Ferguson and Hart, 1985.

Biological Remains

For the past 20 years, archaeologists have been collecting soil samples from archaeological sites for purposes of reconstructing the diets and the environment of the prehistoric occupants of Arizona. Some samples are processed by floatation techniques to recover pieces of wood, plant remains, and animal bones. Other samples are analyzed by microscope to identify minuscule pollen grains and opal phytoliths. These techniques have revolutionized our understanding of the past by allowing archaeologists to make more specific interpretations about their findings. Many of the reports listed in the Bibliography contain detailed information on plant and animal remains recovered from excavations.

In a rare study reported from the plateau area, numerous small sites with and without architectural features were excavated and analyzed (Doyel and Debowski 1980). The location of the sites in areas of accumulated sand dune soils suggested the possibility of agriculture, but hunting and gathering could not be ruled out as possibilities. Refined analysis of environmental variables and associated pollen, botanical, faunal, architectural, and artifactual data revealed a strong focus on sand dune farming during a brief period of the prehistoric sequence.

Squash pollen has been identified in prehistoric Hohokam fields located north of Phoenix and dating to A.D. 1050 (Gish 1985). Pollen analysis was successfully employed to identify prehistoric Hohokam agricultural fields along the Salt-Gila Aqueduct (Fish 1984a, 1984b). Analysis of pollen from features in non-irrigated field sites produced similar sets but lower frequencies of pollen types identified in irrigated fields, suggesting that pollen analysis may assist in distinguishing between irrigated and non-irrigated fields (Fish 1984a:51, but see Gish 1985). The sets of pollen types present may also inform on the season (spring-summer) that crops were grown (Fish 1984a:48). The work of both Fish and Gish should be consulted when designing future work of this nature.

Weedy by-products can also be useful in identifying agricultural fields (Miksicek 1984). The functions of associated property types such as field houses and farmsteads may be identified by the presence and frequencies of botanical remains. Charcoal has been observed in areas containing fields, prompting the inference that fire may have been used in association with agriculture (Dart 1983:627; Dobyns 1981). Charcoal has been observed to depths of two m near field areas at the Gatlin Site in southwestern Arizona, suggesting long-term use of fire; whether it was associated with agriculture remains unclear (Doyel 1993b). Sullivan (1982) proposed that fire was used to prepare garden plots in the forested areas, with the resulting mulch used to enhance crop growth.

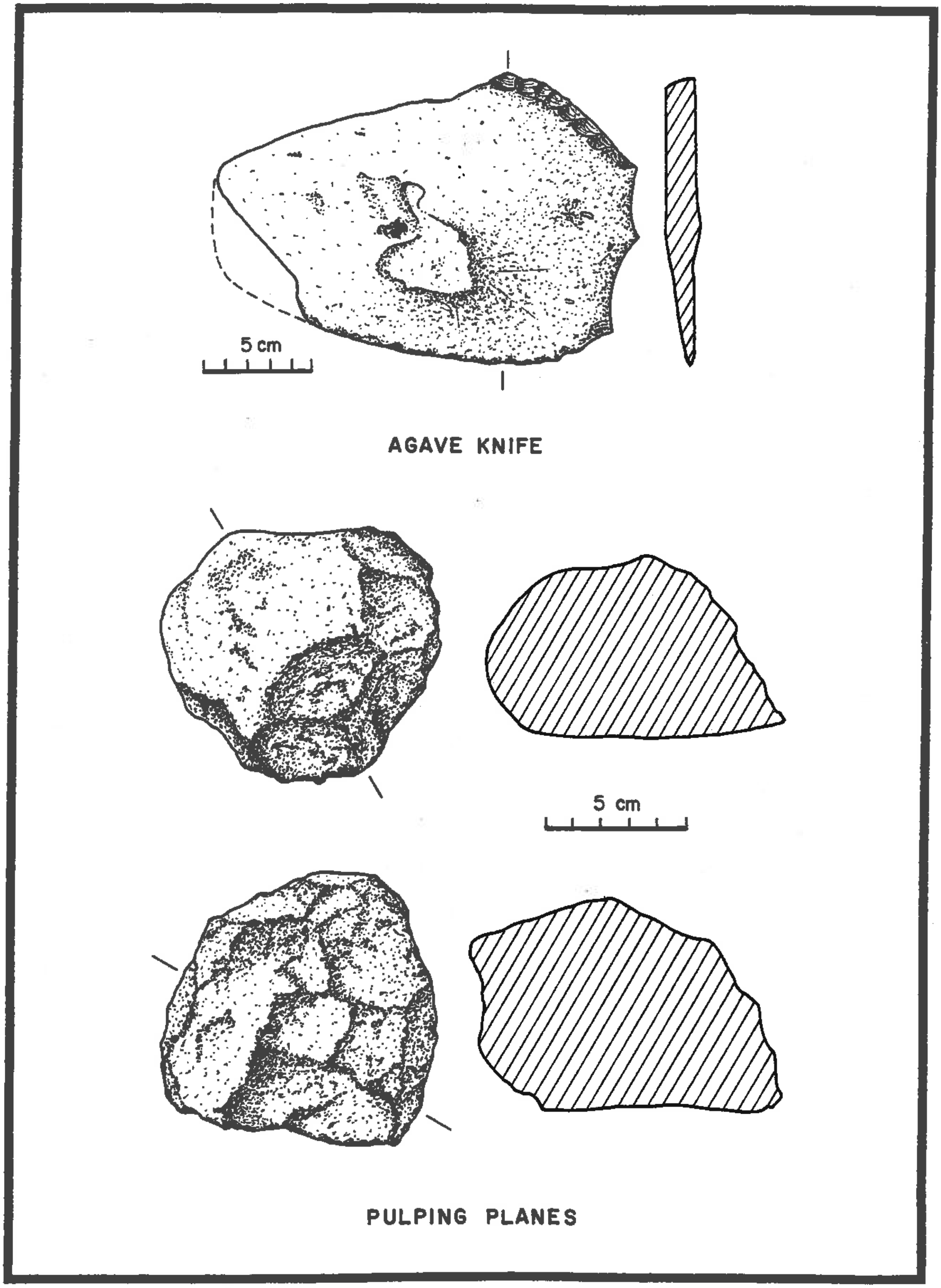


Figure 3-11. Artifacts From Marana Fields.
Adapted from Fish and others, 1992.

Phytoliths

A trend in the identification of prehistoric field systems is through the use of opal phytoliths. These small silica particles form in plants, may be genus or species-specific, and are deposited as the plants decay. Phytoliths should represent firm signatures for field areas, although their absence in proposed fields could be due to erosion or inadequate sampling. Doolittle and Frederick (1991) have developed a key that can be used to identify corn phytoliths and have discussed current limitations of the method.

Soil Chemistry

In a pioneering study, Berlin and others (1977) used soil chemistry analysis to identify prehistoric Sinagua fields. Soil phosphate and salt content from agricultural features were analyzed during the Salt-Gila aqueduct project (Dart 1983:535). The results of the phosphate test were deemed inconclusive, due to near-surface contexts of the samples used, resulting in high levels of organic materials (roots) that would naturally elevate the readings. Salt levels were estimated to be normal for areas under irrigation. Analysis of soil chemistry from archaeological sites in southern Arizona was also recently addressed by Gasser and others (1990).

Mapping and Photography

Berlin and others (1977) discovered prehistoric field systems in northern Arizona while using low elevation aerial thermograms for geological research. Archival and recent aerial photography has been used to study environmental aspects of non-irrigated field systems (Schuster 1990). Sites can also be documented through aerial photography (Masse 1981; Woosley 1980:323), to be followed by ground-based studies. Future fieldwork associated with non-irrigated agricultural sites should employ current high-resolution technology for mapping purposes. The hydro-dynamics of field systems operate on a few centimeters slope (.005 feet per foot of slope is necessary for water to flow and not puddle), detectable only by detailed contour mapping.

Geographic Information Systems (GIS) applications have recently appeared in the archaeological literature. GIS contains great potential to contribute to a wide range of regional studies of non-irrigated agriculture. The method is sufficiently powerful to address questions ranging from shifting land use patterns through space and time to estimates of population and carrying capacity (Altschul and Van West 1992; Van West 1990; Whittlesey 1992).

CHAPTER 4

EVALUATING PREHISTORIC NON-IRRIGATED AGRICULTURAL SITES

Historic properties in Arizona, including prehistoric non-irrigated agricultural sites, are managed through the National Register of Historic Places (National Register). For a site to be considered for protection or treatment under governmental legislation, it must be eligible for, or listed on, the National Register. To be listed on the National Register, properties must possess "integrity", "significance", and must be derived from an identifiable "historic context" (National Park Service 1986:6). The framework of the National Register also involves the concept of property types, which are groupings of individual properties or sites based on shared characteristics.

Historic context information and property type descriptions are provided in Chapters 2 and 3. Discussions of significance and integrity as they relate to prehistoric non-irrigated agriculture are provided in this chapter. The seven criteria of integrity are addressed. A strategy for identifying prehistoric non-irrigated agricultural sites and assessing their eligibility for the National Register of Historic Places is presented.

Evaluating Significance

A property may possess significance if it meets one of more of the four National Register criteria; in lay terms, these refer to associations with:

A. history (broad events or patterns)
B. biography (historically important persons)
C. architecture (distinctive characteristics of a type)
D. archaeology (ability to yield important information)

Criterion A

To be significant under Criterion A, a property must be "associated with events that have made a significant contribution to the broad patterns of our history" (36CFR Part 60.4). Since non-irrigated agriculture provided the foundation for numerous Native American societies, it obviously had a significant impact on the broad patterns of Arizona history. Using the themes listed in National Register Bulletin 42, the prehistory of non-irrigated agriculture is potentially relatable to:

commerce/economics: the role of agriculture in the development of regional economic systems and interaction networks.

community planning: the location of agricultural systems as they relate to spatial integration within communities.

ethnic heritage: the role played by the development of certain types of agriculture in defining local groups.

invention: the development of improved agricultural technologies.

government: the level of political integration necessary to maintain the various types of agricultural systems.

It is unlikely that prehistoric non-irrigated agricultural sites would be eligible under this criterion. Many of the above topics appear to overlap with Criterion D. Nominations based on Criterion A could potentially be viable, however, if several elements were combined to focus on topics relating to cultural preservation, such as, for example, the relationship of certain types of agriculture or certain localities to the preservation of traditional rituals or ceremonies. Only properties with exceptional qualities should qualify under this criterion, including qualities such as strong associations with specific groups, strong spatial integrity, and/or documented oral histories.

Criterion B

To be significant under Criterion B, a property must be "associated with the lives of persons significant in our past " (36CFR Part 60.4). Since the focus of this historic context is prehistoric non-irrigated agriculture, it is unlikely that significance determinations could be based on this criterion. If Criterion B is expanded to include entities other than known individuals, such as, for example, legendary characters or deities associated with agricultural locations, especially compelling evidence should be required, including oral histories and strong spatial associations.

Criterion C

To be significant under Criterion C, a property must "embody the distinctive characteristics of a type, period, or method of construction, or...represent the work of a master, or...possess high artistic values,...or represent a significant and distinguishable entity whose components may lack individual distinction" (36CFR Part 60.4). This criterion is commonly used for buildings with distinctive architectural styles.

Some non-irrigated agricultural property types, specifically field systems, may possess distinctive characteristics of a type, period, or method of construction that may prove temporally, spatially, and/or culturally meaningful in historical or technological contexts. It could also be argued that constructions found in prehistoric fields could qualify as "architecture", or "engineered structures", i.e. built environments. Some field sites encompass significant areas and required considerable engineering skills to construct and deploy. To qualify under this criterion, however, properties should possess unique characteristics including size and complexity and should possess strong integrity values.

Criterion D

To be significant under Criterion D, a property must "have yielded or may be likely to yield, information important in prehistory or history" (36CFR Part 60.4). Most prehistoric non-irrigated agricultural sites will be determined significant under this criterion. The spatial, physical, and associational aspects of such sites contain data relevant to numerous research domains that can be realized when the elements are studied. The development of problem-oriented research designs is instrumental in this process.

A brief overview of prehistoric non-irrigated agriculture in Arizona was provided in Chapter 2; a list of research themes and topics was also presented. Inspection of this list reveals that items one through twenty are directed toward the study of the property types "fields" and "field features and systems." Some issues, such as number eleven, are sufficiently broad to encompass associated property types including field houses, settlements, processing sites, and so on. Issues like nineteen and twenty may be best addressed within the framework of large-scale research programs such as those provided by contract archaeology. Issues twenty one through twenty five are directed toward synthetic and regional topics including settlement patterns, with a focus on associated property types such as settlements, but are certainly not restricted to this topic.

Without context, the potential for any specific non-irrigated agricultural field property to yield important information is difficult to assess. Information return will, in general, vary depending on context, preservation, and post-depositional history. It is important to demonstrate that the basic "why, where, and when" dimensions are contained within the physical features of properties in question. Individual features stripped of their environmental contexts may not yield useful information beyond that gathered during initial investigations. Likewise, associated property types, such as activity areas or field houses, lose much of their interpretive potential if portions of them or their associated field systems no longer exist. Larger, intact systems with associated properties can contribute more useful information important to the interpretation of prehistory.

Evaluating Integrity

To be eligible for the National Register of Historic Places, a property must possess integrity, which is defined as "the ability of a property to convey its significance (National Park Service 1982:44). Seven categories of integrity are recognized, including 1) location, 2) design, 3) setting, 4) materials, 5) workmanship, 6) feeling, and 7) association. A property need not qualify under all seven criteria to be National Register-eligible.

Location

"Location is the place where the historic resource was constructed or the place where the historic event took place" (National Park Service 1982:35). Location is a critical attribute of prehistoric non-irrigated agricultural sites, as it informs on important aspects of the environment. Features located in different settings can inform on the range of farming strategies attempted, on the climatic conditions operative at the time, and on ways environment may have influenced agriculture and settlement patterns. Since non-irrigated agricultural sites are closely articulated with their environmental contexts, and since visible sites consist primarily of built features, removal of these features would undermine the relationship of location.

Design

"Design is the composition of elements that comprise the form, plan, space, structure, and style of a property...Design results from conscious decisions in the conception and planning of a property..." (National Park Service 1982:36). A consideration of design involves determining if the original purpose and function of a property is sufficiently intact to be understood and appreciated.

Conscious design operated in the planning and construction of prehistoric non-irrigated agricultural sites. Site elements and features share historical and functional relationships, the meaning of which can be obtained through detailed research. The absence of critical portions of a field property, the up-field locations near the water source, for example, could seriously undermine attempts to ascertain the overall design of a system. Design also informs on function, and is necessary for complete understanding of a system. Without study of design, knowledge of function may be incorrect, incomplete, or absent. Design is also capable of informing on the level of technological knowledge and engineering capabilities present within a society, as well as the concomitant social organization necessary to effect and maintain the design.

Setting

"Setting is the physical environment of a historic property (that) illustrates the character of the place in which the resource played its historical role" (National Park Service 1982:36). Prehistoric non-irrigated agricultural sites are not randomly distributed over the landscape but are located in highly patterned environmental contexts. They were purposefully constructed in specific contexts in response to a perceived set of resources that might include soil, water, slope, available labor, etc. The integrity of setting may be adversely impacted by post-occupational processes that obscure this set of target resources and by developments subsequent to the prehistoric occupation. If most of a field system has been altered, it may be difficult or impossible to reconstruct the original setting within which the system operated.

Materials

"Materials are the physical elements that were combined or deposited in a particular pattern... to form a district, building, structure, or object in a particular period in the past. The retention of pattern within deposited materials is important in evaluating the integrity of materials in archaeological sites because often much of the important information that a site contains is based on the distribution of features and artifacts within the site" (National Park Service 1982:36).

Features present on prehistoric non-irrigated agricultural sites consist of materials that may be local or non-local in origin or a combination of the two. Determining which situation (local or non-local) applies to a particular set of properties provides important information about construction requirements and socio-economic practices. Retention of the pattern of construction is critical in evaluating the integrity of particular properties. Integrity of materials in their depositional context is critical for evaluating the potential for a property to yield useful information.

Workmanship

"Workmanship is the physical evidence of crafts of a particular culture or people during any given period in history or prehistory. It is the evidence of the craftmen's labor and skill in constructing a building, structure, or object, or altering, adapting, or embellishing a site" (National Park Service 1982:37).

Study of prehistoric non-irrigated agricultural sites has revealed an overwhelming emphasis on function without embellishment across associated property types. Field systems consist of unmodified materials, of which only the stone fabric remains. It is the aggregate meaning of these prosaic features that testifies to the "workmanship" and engineering achievements of prehistoric peoples.

Feeling

"Feeling is the quality a historic resource has in evoking the aesthetic sense of a past period of time, (and) depends upon the presence of physical characteristics to convey the historic qualities that evoke feeling" (National Park Service 1982:37). It is difficult to imagine a property type that would evoke a more subjective feeling than would gazing upon a set of prehistoric non-irrigated agricultural features. Large sites may be impressive in the aggregate due to perceived values of shared labor and scale of construction. Individuals familiar with the subject could be highly impressed by the creative and ingenious methods devised to grow crops. Others might experience a gestalt-like response while viewing a culturally-modified landscape. Still others would see little more than a mass of piled rocks. In most cases, the criterion of feeling would not appear to be critical to this topic.

Association

"Association is the direct link between a property and an event, person, and so on, for which the property is significant" (National Park Service 1982:37). There is not always a one-to-one association between the existence of features or properties that resemble prehistoric non-irrigated agricultural sites (such as rock piles, stone alignments, etc.) and agriculture. The linkage must be empirically established through arguments of relevance.

It is possible that Native American traditions contain linkages among events and persons, real or otherwise, with particular settings. The potential exists for the aspect of association to be important with regard to prehistoric non-irrigated agricultural sites. Without research, the extent to which this aspect could apply is unknown.

Assessing Prehistoric Non-Irrigated Agricultural Sites

The identification and characterization of prehistoric non-irrigated agricultural sites can be challenging. A system is provided for assessing the potential of sites to be classified as prehistoric non-irrigated agricultural sites based upon evidence normally encountered during archaeological field survey. As was discussed in Chapter 4, plant residues recovered from critical contexts often provide the strongest case that agriculture occurred in a particular vicinity. Unless subsurface testing is associated with field survey, however, these critical data cannot be obtained. Rare situations may be encountered, such as corn cobs or other remains eroding from exposed features, but cannot be expected to occur under survey conditions. Other critical tests are needed for purposes of evaluating the potential for non-irrigated agriculture to have occurred at a particular site.

This framework employs three different data sets that can be used in isolation or in combination to evaluate the hypothesis that prehistoric non-irrigated agriculture occurred at a particular site (Table 4-1). These data include the presence or absence of field features, artifacts, and other features. Evaluated within the site's environmental context, the presence or absence of these attributes provides a framework for developing arguments of relevance to determine the presence of prehistoric non-irrigated agricultural sites using a scale of high to low probability.

In many localities, runoff fields are identifiable by the presence of field features, including rock piles, alignments, terraces, etc. For areas where most agriculture was of the floodplain or dry farming types, such as the Colorado River Valley and the Hopi Mesa areas, evidence other than field features must be emphasized in developing arguments of relevance. The presence of field features in an appropriate environmental context strongly suggests that fields were located nearby. Site context is a critical element of the assessment. For example, a rock pile or a stone alignment on rocky pavement or on a steep slope may suggest a hunting blind along a trail, or a defensive feature, and not an agricultural feature. Other rock piles may represent shrines, trail markers, or even raw material caches for the production of tools.

Key artifacts can be used either in isolation or in combination to evaluate the possibilities. Pulping planes and tabular knives are often associated with agave fields. These two tool types found together would suggest a focus on agave harvesting. Other artifacts, such as stone hoes and ground stone tools, may also be associated with agricultural sites. Field context would be an important aspect of the analysis in these cases.

The third data class is the presence or absence of fixed features associated with agriculture, including the range of associated property types presented in Chapter 4. Like artifacts, this class of data is often indirect, and some are more commonly associated with fields than others. Roasting pits located in or near possible field areas may provide clues to site function. Other indirect measures of agriculture are the presence of "field houses" and perhaps "limited activity sites".

Used in association with environmental analysis, combinations of these data classes can provide powerful arguments for or against the presence of non-irrigated agriculture in any specific area. For example, the presence of field features and roasting pits along with tabular knives and pulping planes provides a rating of one on the scale; agave cultivation is strongly indicated. Likewise, the presence of field features, roasting pits, and ground stone tools, along with the absence of tabular knives and pulping planes, provides a strong case for agriculture, perhaps corn and not agave. The further down the scale, the weaker the argument. Ratings of

TABLE 4-1.

Inferential Scale for Assessing Prehistoric Non-Irrigated Agricultural Sites

1. Presence of field features, key artifacts <u>and</u> other features
2. Presence of field features, and either key artifacts <u>or</u> other features
3. Presence of arable land, key artifacts <u>and</u> other features
4. Presence of arable land, and either key artifacts <u>or</u> other features
5. No arable land but presence of key artifacts <u>and</u> other features
6. No arable land but presence of key artifacts <u>or</u> other features

five or six would not strongly support an inference of an agricultural function for a particular site.

Other important considerations exist in the assessment of the information potential of non-irrigated agricultural sites. Individual features should possess internal integrity; that is, they should not have suffered from any subsequent cultural and natural disturbances. Looted or disturbed sites contain less potential to provide information.

Dating is a critical concern. If properties can be dated, their potential is greatly increased due to the number of research issues pertaining to the historical and evolutionary development of such systems. Agricultural systems associated with settlements provide a larger community context within which to conduct analysis and to consider the significance of individual properties. It is preferable that entire systems be available for study. If only a few elements of a once larger system remain, their information potential is diminished.

Based on the above considerations, priority for eligibility determinations should be given to non-irrigated agricultural sites meeting the following criteria:

1) features that possess internal integrity,
2) features with potential to contain subsurface deposits,
3) features that exist as parts of intact systems,
4) features that are datable, and
5) features or systems that are associated with communities.

It is unnecessary that individual properties possess all the above qualities to be eligible for the National Register. Properties that represent significant engineering skills which have integrity but are not associated with a community or not immediately datable should be eligible. Properties need not possess the full range of feature types to be National Register-eligible. An impressive set of check dams may qualify at one site, while another site may be significant for the diversity of features present.

Regional distributions of non-irrigated agricultural sites are also important in assessing the significance of specific properties. If such properties are rare in a particular area, their existence increases their value; they may represent a failed experiment or the efforts of pioneering populations. Ultimately, assessment of the significance of non-irrigated agricultural sites should involve considerations at three levels, including the site, the locality, and the region.

CHAPTER 5

MANAGING PREHISTORIC NON-IRRIGATED AGRICULTURAL SITES

This chapter identifies some activities that threaten prehistoric non-irrigated agricultural sites. Priorities for future research and documentation are suggested. Actions that could be taken by the SHPO to promote resource protection, management, and the advancement of knowledge are identified.

Prehistoric Non-Irrigated Agricultural Sites Are Threatened

Seventy percent of the respondents (18 of 26 individuals) to the questionnaire stated that prehistoric non-irrigated agricultural sites in their research areas were being threatened. The most common threat was "development," but agriculture and recreation were also cited. Livestock grazing, mining, fire wood cutting, juniper chaining, vandalism, and erosion were also cited.

Twenty-eight percent of the respondents indicated that preserving non-irrigated agricultural sites should be given a high priority, while fifty percent suggested that medium priority was appropriate. Fifteen percent said that priority should depend on the context of the site, while only eight percent suggested a low priority be given to this class of sites. Some thought that agricultural features associated with settlements should be given priority over isolated examples where less could be learned. One comment indicated that "We need to preserve cultural systems... Non-irrigated agricultural sites are important elements of cultural systems, and we need to think of these sites as parts of landscapes, and not as sites."

Properties Listed on the National Register of Historic Places

Only a few sites associated with prehistoric non-irrigated agriculture are listed on the National Register of Historic Places. While not listed because of their agricultural associations, in some cases agricultural associations are contributing elements. Recent nominations show a trend toward a district approach that combines a range of property types (habitation, field house, etc.) which include agricultural systems within a community setting.

Site or District	County	Date Listed
Chavez Pass Pueblo (Navaqueotaka)	Coconino	1977
Houston Mesa Ruins (Shoofly Village)	Gila	1986
Marijilda Canyon Archaeological District	Graham	1988
Perry Mesa Archaeological District	Yavapai	1975
Los Robles Archaeological District	Pinal	1989
McClellan Wash Archaeological District	Pinal	1989
Sutherland Wash Archaeological District	Pima	1988
Gunsight Mountain Archaeological District	Pima	1991

Priorities for Survey

Despite recent gains, data gaps are present in most regional sequences. In general, there is a lack of systematic inventory survey to locate and document non-irrigated agricultural sites. A common opinion held by archaeologists is that a lack of experience has resulted in under-recording of non-irrigated agricultural sites in previously surveyed areas. While significant contributions are being made, basic research remains limited and without focus.

Two strategies for surveying and potentially nominating prehistoric non-irrigated agricultural sites to the National Register of Historic Places are recommended. Priorities for state-wide survey should be placed on endangered sites and those areas experiencing rapid development; these include growing urban and agricultural areas, including but not limited to the Flagstaff, Phoenix, and Tucson metropolitan areas. The recent survey completed as a part of the "Hohokam Communities of the Lower Santa Cruz River Basin" thematic group is an excellent example of the quality of information and range of properties found in association with agricultural communities. Similar studies should be conducted around communities in other areas; for example, none of the large Chacoan communities in northern Arizona have been surveyed and recorded with a focus on agricultural sites and community patterns. Likewise, few studies of non-irrigated agricultural sites in southeastern Arizona have been undertaken.

A second strategy would be to undertake site-specific studies to document and nominate the range of variation present within prehistoric non-irrigated agricultural sites that possess strong cultural, scientific, and interpretive values. Particularly outstanding examples are the terraced gardens still in use by the Hopi, the New River agave fields, the extensive systems in the Santan Mountains and the gridded gardens of the middle Gila River.

Properties Potentially Eligible for the National Register of Historic Places

The following non-exhaustive, alphabetical listing provides some examples of prehistoric non-irrigated agricultural sites that require additional documentation and evaluation for nomination to the National Register of Historic Places as sites or as districts.

Agua Fria gridded gardens (Dove 1970)
The extensive gridded gardens located in the Calderwood Butte area are excellent examples of agricultural field systems that are endangered by the expansion of Phoenix; priority should be placed on documenting these systems.

Black Mesa farming sites (Bearden 1984; Matson 1991)
Some of the earliest habitation sites associated with agriculture in Arizona are located on Black Mesa and are important in the study of the transition from hunting and gathering to agriculture. Excavations in these sites have produced information of exceptional value.

Chacoan communities (Gilpin 1989; Fowler and Stein 1992)
Numerous communities associated with the Chacoan culture are located in northeastern Arizona. Agricultural practices associated with these communities are poorly documented (see Breternitz and others 1982 for an example of documentation for a Chacoan community located in northwestern New Mexico). Fields, field systems, and associated features are associated with these communities. The lack of modern disturbance at these sites, such as Navajo Springs, for example (Warburton and Graves 1992), provides properties of exceptional significance for research and preservation, and offers excellent interpretative potential that could tie into the efforts of the Navajo Nation to promote tourism.

Continental Wash area (Stone 1986)
This portion of southwestern Arizona is known to contain a cultural sequence from the Archaic to historic periods. Unique non-irrigated agricultural adaptations may have existed in this area. Field study would further define the nature and complexity of agricultural systems.

Long House Valley sites (Dean and Lindsay 1978)
Long House Valley in the western Navajo Reservation is known for its lengthy archaeological sequence and its village sites. Associated with these villages are numerous agricultural fields, field systems, and associated properties. Some research has been undertaken to document the range of special function sites in the area.

Middle Gila River gridded gardens (Woosley 1980)

BLM Archaeologist Gay Kincade (personal communication 1992) reports that the following non-irrigated agricultural strategies are thought to have been practiced in the Middle Gila River area around Safford and in southeastern Arizona: dry farming, runoff, diversion, floodwater, floodplain inundation, arroyo bottom, terrace, and storage basin inundation. A variety of fields, field systems, and associated property types are present. Potential National Register-eligible properties include the Gila River Gridded Gardens (sites AZ CC:1:2 and AZ CC:1:13 (ASM)), rock pile fields on state land between Pima and Thatcher, and field systems along the Gila River near Kearney.

New River agricultural sites (Doyel and Elson 1985; Green 1989)

Several projects undertaken for the Army Corps of Engineers and the Bureau of Reclamation have documented extensive agricultural areas along the New River located north of Phoenix. A variety of agricultural systems are present that document a continuum from small-scale irrigation to extensive floodwater farming. Excellent examples of well-preserved fields, field systems, and associated properties are present.

New River agave fields (Rankin in Green 1989)

The scientific community was startled and excited by the discovery in the 1980's that native agave was still growing within stone terraces built by the Hohokam 1,000 years ago. Stone tools used to process the plants can be found nearby. Rare opportunities exist for documentation and public interpretation, and should be given high priority.

Point of Pines water-control sites (Woodbury 1961; Cordell 1984)

Woodbury's research on the prehistoric agricultural systems at Point-of-Pines in east-central Arizona was a pioneering effort. Many of the systems retain excellent integrity and are associated within pristine multi-site communities, providing an excellent cultural context for research.

Sacred Mountain Pueblo District (Fish and Fish 1984)

The waffle gardens in Beaver Creek and the field systems in Long Canyon represent excellent examples of Sinagua non-irrigated agricultural systems and property types.

San Pedro River agricultural sites (Masse 1980)

Extensive non-irrigated agricultural field sites are located on gravel terraces above the river floodplain, including those in Arizona State Museum (ASM) grids AZ BB:2 through AZ BB:6. Masse (1980:216) estimates that 10,000 acres of such fields exist between Redington and Winkleman. Given their proximity to expanding commercial and metropolitan areas, documentation of these systems should be given priority.

San Francisco Peaks volcanic field (Pilles 1979; Sullivan 1984)
Since H. Colton's classic work "Black Sand", both the public and the archaeological community have been intrigued by the unique adaptations of Native Americans to the cinder-covered fields around Flagstaff and their association with Sunset Crater. Fields, field systems, and associated property types are abundant. Additional documentation is needed, and the possibilities for public interpretation are unlimited.

Santa Cruz River reservoir sites (Bayman 1992)
Ongoing research has revealed a large number of constructed reservoirs along the Santa Cruz River and in the more arid regions to the south and north. These reservoirs are thought to have been used for domestic and agricultural purposes. The range of agricultural strategies used in association with these sites has not been documented. These villages containing reservoirs may have played an integral role in regional trade and interaction patterns. Some settlements are well preserved and would be ideal candidates for community studies.

Santan Mountains gardens (Cantley 1991; Rice and others 1979)
The extensive agricultural systems located near the Gila River along the Santan Mountains are known to archaeologists but remain poorly documented. Multiple field sites are known for their size, having been described as continuing for miles. Preservation of some systems is excellent. A wide variety of field features and field systems is present; large village sites are also located nearby. Some properties may be included in the Maricopa County Santan Regional Park.

Tumamoc Hill (Masse 1979)
In one of the first systematic studies of Hohokam non-irrigated agriculture, Masse described a wide range of agricultural features, some probably associated with agave cultivation, located along the slopes and flats around Tumamoc Hill in Tucson. Hundreds of field features and field systems are present, but as of this writing the integrity of the site is unknown. The site could represent an excellent opportunity for public interpretation.

Walnut Flat near Shoofly Village (Doyel 1991b)
Numerous well-preserved water-control systems and associated properties (field houses, check dams, etc.) are located near Shoofly Village (a National Register Site) near Payson that have excellent interpretive potential.

Strategies for the Management of Prehistoric Non-Irrigated Agricultural Sites in Arizona

A number of recommendations can be made for the management of prehistoric non-irrigated agricultural sites; these include documentation, preservation, training, and public education.

1. Aggressively support field survey to locate and document agricultural sites following the two strategies identified, and, when appropriate, actively pursue their nomination to the National Register of Historic Places.

2. Actively support the development of improved data management systems that can provide more accurate descriptions and other data to enable better management of prehistoric non-irrigated agricultural sites.

3. Fund an extensive aerial photography inventory program to document agriculture-related properties for management and analytical purposes.

4. Actively monitor site protection through support of voluntary organizations such as the Site Steward Program.

5. When possible, preserve examples of agricultural systems within park settings for public interpretation (eg. Pueblo Grande, Park of the Canals).

6. When possible, establish preserves through land exchanges and preservation easements.

7. Sponsor symposia to train archaeologists to identify and record agricultural systems.

8. Produce an illustrated field guide containing standardized terminology for prehistoric agricultural systems.

9. Fund overviews, oral histories, and ethnographic studies to provide more specific historic contexts for evaluating non-irrigated agriculture. Produce a video on traditional agricultural practices that integrates prehistoric and historic information.

10. Make information available to the public through publications, lectures, and programs, such as Arizona Archaeology Week.

There is much that can be done. Some activities, such as public interpretation, do not require great amounts of resources to implement. Networking among the SHPO, other agency staff, private-sector individuals and companies, Native Americans, and other interested parties could produce both short-term and long-term action plans for implementing these recommendations.

APPENDIX 1

QUESTIONNAIRE: PREHISTORIC NON-IRRIGATED AGRICULTURE IN ARIZONA

1. What do you see as the major issues involved in the study of non-irrigated agriculture in Arizona?

2. What types of non-irrigated agriculture were practiced within your geographic study area during the prehistoric period? Examples could be sand dune, ak chin, terrace, etc.

3. What site types, features, landforms, etc. are associated with prehistoric non-irrigated agriculture in your study area? Please supply an example of a site or area.

4. What is the strongest direct evidence for non-irrigation agriculture at a site or locality in your area? Often, non-irrigation agriculture leaves little archaeological evidence. List in priority what types of indirect evidence you would look for in such cases?

5. Can changes through time or space be identified in the practice of non-irrigated agriculture in your study area? **circle one:** yes or no. If so, what are they?

6. What data gaps or deficiencies in knowledge exist regarding non-irrigated agriculture in your study area?

7. Are non-irrigated agricultural sites in your study area being threatened by current land-use or other activities? **circle one:** yes or no. If so, what type(s) or activities?

8. Do you think that prehistoric non-agricultural sites should be saved? **circle one:** yes or no. Should preservation of such sites be a high, medium or low priority? **circle one** What value(s) do they contain or represent?

9. What actions could be initiated by government agencies or by researchers to identify, study, and manage the properties associated with the different forms of prehistoric non-irrigated agriculture in Arizona? Do you think that non-irrigation agricultural sites could be nominated to the National Register as Districts? **circle one:** yes or no. Can you supply any examples?

10. Can your name be identified with any of your responses in the report? **circle one:** yes or no.

APPENDIX 2

ANNOTATED BIBLIOGRAPHY FOR NON-IRRIGATED AGRICULTURE

This annotated bibliography provides a sample of materials available on prehistoric non-irrigated agriculture from the three provinces in Arizona, including the desert, mountains and plateau. Most are somewhat to highly technical, but several (*) are written for a general audience.

Anderson, Bruce (compiler)
1990 The Wupatki Archeological Inventory Survey Project. National Park Service, Southwest Cultural Resources Center, Professional Paper No. 35, Santa Fe.

This impressive volume presents the results of an intensive survey of Wupatki National Monument located in the Little Colorado River Valley in northern Arizona. Included are discussions of environment, site types, settlement patterns, ethnohistory, and artifacts. One chapter focuses on prehistoric agriculture, and describes the composition of field systems, associated environment, and the evolution of local agricultural systems.

Buskirk, Winfred *
1986 The Western Apache: Living With the Land Before 1950. University of Oklahoma Press, Norman.

Much useful information about Western Apache subsistence prior to 1950 is included in this book. One chapter provides information about Apache farming practices, site selection, land ownership, crop varieties, and associated ritual. Recommended for non-specialists.

Castetter, E. and W. N. Bell
1942 Pima and Papago Indian Agriculture. Inter-American Studies I, University of New Mexico Press, Albuquerque.

1951 Yuman Indian Agriculture. Inter-American Studies III, University of New Mexico Press, Albuquerque.

These studies of the O'odham and Yuman peoples provide the basis for archaeological interpretation of prehistoric non-irrigated agriculture in southern and western Arizona. Agricultural observations are supplemented with ethnographic information and environmental analysis.

Crown, Patricia
1984 Adaptation through Diversity: An Examination of Population Pressure and Agricultural Technology in the Salt-Gila Basin. In Prehistoric Agricultural Strategies in the Southwest, edited by S. and P. Fish, pp. 5-26. Anthropological Research Papers, Arizona State University, Tempe.

1987 Classic Period Hohokam Settlement and Land Use in the Casa Grande Ruins Area, Arizona. Journal of Field Archaeology 14:147-162.

Information is provided on the extensive excavations along the Salt-Gila Aqueduct project, which provided a transect along the basin margins between the Salt and Gila River valleys. Considerable diversity is present within the region, although long considered to be a focus of Hohokam irrigated agriculture. Topics include agricultural technology, subsistence, and settlement patterns.

Debowski, Sharon, A. George, R. Goddard, and D. Mullon
1976 An Archaeological Survey of the Buttes Reservoir. Arizona State Museum Archaeological Series 93, Tucson.

A total of 250 prehistoric sites, including 36 agricultural sites, were recorded in this large survey along the Gila River east of Florence. The project revealed that the Hohokam invested considerable resources in non-irrigated agricultural strategies in riverine areas. A variety of field features are present. It has been suggested that much of this activity focused on the production of agave.

Doolittle, William
1984 Agricultural Change as an Incremental Process. Annals of the American Association of Geographers 74:124-137.

1988 Prehistoric Occupance in the Valley of Sonora, Mexico. Anthropological Papers of the University of Arizona 48, Tucson.

Although the focus is northern Mexico, these studies are relevant to prehistoric agriculture as practiced in the Sonoran Desert region. They describe how agricultural systems grow and expand as they are used.

Doyel, David and Sharon Debowski (editors)
1980 Prehistory in Dead Valley, East-Central Arizona: The TG&E Springerville Report. Arizona State Museum Archaeological Series 144, Tucson.

Doyel, David
1981 Prehistoric Environment, Land use, and Subsistence in Dead Valley, East-Central Arizona. Kiva 46:143-154.

Numerous prehistoric (Pueblo II period) sites found in association with sand dune fields were excavated. Botanical, pollen, and artifactual evidence provide strong evidence of agricultural activities. Discussions focus on property types and associated environmental, subsistence and artifactual data. The Kiva article provides a summary that is recommended for non-specialists.

Doyel, David and Mark Elson
1985 Hohokam Settlement and Economic Systems in the Central New River Drainage, Arizona. Soil Systems Publications in Archaeology No. 4, Phoenix.

Numerous Hohokam sites dating between A.D. 800-1100 in the northern Salt River Valley were excavated. Agricultural field sites, features, and associated activity areas including ground stone manufacturing loci, are described. While most agriculture focused on small ditch irrigation emanating from the New River, evidence suggests that floodwater systems, including terrace and ak chin, were a part of the agricultural technology. Features used for irrigated agriculture (rock piles, alignments, terraces, etc.) are described.

Fish, Suzanne and Paul Fish (editors)
1984 Prehistoric Agricultural Strategies in the Southwest. Anthropological Research Paper 33, Arizona State University, Tempe.

A compilation of 21 individual studies of prehistoric agriculture in the Southwest, 13 of which provide a range of geographic, cultural, and temporal topics focusing primarily on non-irrigated agriculture in Arizona; examples from the desert, mountains, and plateau are included. Site features, artifacts, environmental variables, and associated social implications of agricultural variation are addressed.

Fish, Suzanne, Paul Fish, and John Madsen (editors)
1992 The Marana Community in the Hohokam World. Anthropological Papers of the University of Arizona No. 56, Tucson.

Information is provided on the extensive agricultural complex within the Classic period community of Marana located near Tucson. Included are discussions of micro-environmental variation and agricultural production, the archaeology of agave cultivation, and the evolution of agricultural and settlement patterns in the region.

Forde, C. Daryll *
1934 Habitat, Economy, and Society. Harcourt and Brace, New York.

This classic study investigates the relationships among agricultural practices and other aspects of native southwestern societies. The topics addressed range from the identification of field locations to food preferences. Recommended for non-specialists.

Frazier, Kendrick *
1986 People of Chaco. Norton and Co., New York.

This book was written for the non-specialist and covers a wide variety of topics regarding Anasazi society, including detailed discussions of agriculture and irrigation. Ethnographic information from Pueblo culture is interspersed throughout the volume.

Gasser, Robert, C. Robinson, C. Breternitz
1990 Archaeology of the Ak-chin Indian Community West Side Farms Project: The Land and the People. Soil Systems Publications in Archaeology No. 9(2), Phoenix.

This study focuses on the excavation of prehistoric sites associated with non-irrigated agriculture. A discussion of ak-chin farming is presented that uses ethnographic data and also addresses archaeological applications.

Hack, John T.
1942 The Changing Physical Environment of the Hopi Indians of Arizona. Papers of the Peabody Museum of Archaeology and Ethnology 35(1), Cambridge.

This classic study explores the range of non-irrigated agriculture as practiced by the Hopi people northern Arizona. Descriptions are provided of field types and farming features used and how they function.

Matson, R.G.
1991 The Origins of Southwestern Agriculture. University of Arizona Press, Tucson.

This comprehensive study provides information on the origins of agriculture and includes an assessment of the dating of non-irrigated agricultural sites. An evolutionary model is presented that includes discussions of floodwater and runoff farming practices. Cultural overviews are also presented.

Nabhan, Gary Paul
1983 The Ecology of Floodwater Farming in Arid Southwestern North America. Agro-Ecosystems 5:245-255.

1986 Papago Indian Desert Agriculture and Water Control in the Sonoran Desert, 1697-1934. Applied Geography 6:43-59.

These short articles describe O'odham non-irrigated (ak chin) agricultural practices, with a focus on relationships among environmental variables (soil, water, topography, etc.) and cultural practices related to agriculture.

Ortiz, Alfonso (editor)
1983 Handbook of North American Indians, Volume 10: Southwest. Smithsonian Institution, Washington, D.C.

Over 50 articles are included in this volume on the Native American peoples of the Southwest. Summaries of traditional and/or modern economic systems, including agricultural practices, are included. Recommended for non-specialists.

Stone, Connie
1986 Deceptive Desolation: Prehistory of the Sonoran Desert in West-Central Arizona. Bureau of Land Management Cultural Resource Series No. 1, Phoenix.

1987 People of the Desert, Canyons, and Pines: Prehistory of the Patayan Country in West Central Arizona. Bureau of Land Management Cultural Resource Series No. 2, Phoenix.

These documents provide detailed discussions of aboriginal subsistence practices, including agriculture, in western Arizona, an understudied area.

Sullivan, Alan
1982 Mogollon Agriculture: An Appraisal and a New Model. Kiva 48:1-16.

The author contends that, in contrast to Puebloan alluvial strategies, agriculture practiced in the mountains of central Arizona was similar to burn-plot farming strategies used by native peoples in the high altitude forested regions of northern Mexico.

Tuggle, H. David, J. Reid and R. Cole
1984 Fourteenth Century Mogollon Agriculture in the Grasshopper Region of Arizona. In Prehistoric Agricultural Strategies in the Southwest, edited by S. and P. Fish, pp. 100-110. Anthropological Research Papers, Arizona State University, Tempe.

This study is one of the few available for prehistoric agriculture in the mountains of central Arizona (also see Woodbury 1961). Discussions of agricultural technology (check dams, terraces, field structures, etc.) are provided along with settlement patterns relative to soil types, focusing on the area surrounding Grasshopper pueblo.

Vivian, R. Gwinn
1990 The Chacoan Prehistory of the San Juan Basin. Academic Press, New York.

1992 Chacoan Water Management. In Anasazi Regional Organization and the Chaco System, edited by D. Doyel, pp. 45-57. Maxwell Museum Papers in Anthropology No. 5, Albuquerque.

Detailed information is provided on the Chaco culture, which extended into northeastern Arizona. The Chaco adaptation appears to have been associated with an intensification of particular types of labor-intensive agriculture. The water management article provides quantitative information on water requirements for farming in the region.

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