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LESSONS FROM SOUTHWESTERN INDIAN AGRICULTURE

By S. P. Clark

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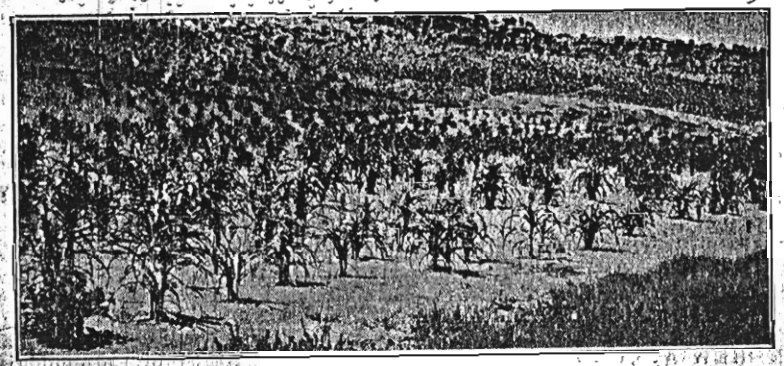

Hopi Indian corn field. Planted in very sandy soil in conical holes 10 or more inches deep and with 15 to 20 kernels in a hill.

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LESSONS FROM SOUTHWESTERN INDIAN AGRICULTURE

By S. P. Clark

INTRODUCTION

This bulletin was written to make available some of the agricultural practices of the Indians of the Southwest, that have enabled them to live through long periods under extremely adverse conditions.

The first part of the bulletin concerns principally the Hopi Indians, who are located on the Hopi-Navajo Reservation in northeastern Arizona. This reservation is about 100 miles north of Holbrook, and can be reached by stage from Holbrook, Flagstaff, or Winslow.

Because of their isolation these Indians are in many respects among the most primitive in the United States. The agricultural methods by which they have lived are of interest to farmers and others of the Southwest.

The larger number of the Hopi Indians live in four villages, Walpi, Toreva, Oraibi, and Hotevilla, each of which is situated on a high mesa. Until a few years ago Hotevilla was a part of the Oraibi settlement. These mesas, or table-lands are all small in area, nearly flat on top, and composed largely of rocks with occasional patches of sand. The walls of the mesas rise abruptly from the surrounding plain and are in places 200 feet high.

THE COUNTRY AND CLIMATE OF THE HOPI

Centuries ago the Hopis lived and farmed in much more favorable locations along the Little Colorado. This is evidenced by the many ruins found along this stream, and is substantiated by legends of the tribe. Through hundreds of years of warfare with nomadic Navajo and war-like Apache tribes, the Hopis (meaning peaceful) were driven step by step from the more favorable soil and climatic conditions into this extremely arid and semi-arid country. The rainfall averages less than 12 inches per annum. The little snow that falls during the winter is depended upon to start the desert vegetation in the spring. During the latter part of July and through August there are local

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thunder showers, but these are seldom extensive enough to cause sufficient water to run in the arroyos (dry washes) to reach the Little Colorado. In this country, as is quite common under semi-arid conditions, the rainstorms are accompanied by heavy winds which often dissipate the clouds before they reach the mesas.

The windstorms of the Hopi country at times are severe. The hardest gales occur in the spring, when the wind-driven sand cuts off the tender growth of vegetation. It also causes a great deal of damage by blowing the sandy soil away from around the roots of orchard trees and growing crops.

The average elevation is about 6,500 feet; the nights are cool, which retards the growth of crops, and there is seldom any dew.

EFFECT OF NEIGHBORING TRIBES ON THE LIFE OF THE HOPI

Previous to the time that the Government began to exercise some control over the Indians, the Hopis could farm only small patches of arable ground on the mesas or close to the foot of the mesas. Even then it was precarious, for frequently a Navajo or Apache foraging party would swoop down on the little farm and help themselves to the crop, robbing the Hopi farmer of the returns of his season's labor. The Hopis are, from the nature of their environment and economic conditions, practically vegetarians. They never possessed herds of cattle, sheep, or goats until quite recently because of the difficulty of protecting them from Navajo raiding parties. Occasionally they caught a rabbit, prairie dog, or squirrel, or obtained a sheep or a goat from a Navajo in exchange for corn or melons.

Corn is the mainstay of the Hopi housewife's menu and she has many methods of preparing it. The Hopis appreciate the value of green food and its substitutes in their diet and gather many native herbs, tie them in bundles to dry, and preserve them for winter use. A partial list of the crops they grow includes corn, watermelons, muskmelons, squashes, onions, beans, chili, sunflowers, wheat, sorghum, tomatoes, cotton, potatoes, grapes, pumpkins, garlic, coxcomb, coriander, false saffron, tobacco, peaches, apricots, and apples.

HOPI AGRICULTURE AND THE SELECTION OF FIELDS

The Hopi Indian exercises good judgment in the selection of his fields for farming. If possible, he chooses low land along a wash that is subject to overflow during the summer rains, or

land that can be flooded by simply building a temporary diversion dam across the wash. Very frequently he builds dams across the washes a month or 6 weeks before there is any likelihood of local rains. These dry arroyos sometimes have their sources as much as 100 miles from the farmer's land, and flood waters may come down very unexpectedly, from rains that fall many miles away. When there is a heavy shower, the Hopi will, in order to make use of all the water possible, go out during the rain and work for hours throwing up dikes and leading the water by little ditches over his field. These fields usually have a stratum of impervious clay 4 or 5 feet below the surface. The Hopi farmer appreciates the fact that the clay holds the moisture where the plants can use it, and retards the downward percolation of water to better advantage, than does a uniformly sandy soil. He also knows that a layer of sand on top of the heavier soil acts as a mulch in retarding the loss of water by evaporation and thus permits the seedlings to come through more readily.

Frequently a farm is located where there is no possibility of making use of runoff water. Under these circumstances the soil has a substratum of heavy clay covered several inches deep with very sandy soil.

In some localities, as on the Hotevilla mesa, the only soil available is composed of practically pure sand with a very small percentage of clay and humus. A high sandhill occupies the central part of this mesa. This hill is barren, except where the Indians have planted peach orchards and crops.

PLANTING METHODS

The planting season follows immediately after the first spring rains, which usually come about the middle of May. The Hopis do very little work, and in the majority of cases none at all, to prepare the land for planting. The dead weeds or brush that may be in the field are cut off after the crop is harvested in the fall and left for the wind to blow away. Also at this time the fields are ditched to collect any moisture that may fall during the winter. There are very few plows or modern farming implements on the Hopi reservation. The principal tools are a large hoe for cultivating and harvesting, and a planting tool, which is a stick about 2 feet long and from 1 to 2 inches thick, flattened at one end for digging. With the latter, the Hopi gouges out a hole 6 to 8 inches deep and 4 to 6 inches wide, and loosens the soil in the bottom. He then puts in 15 to 20 kernels of corn, fills the hole and firms the soil. Where the soil is very sandy and not subject to overflow, conical holes are dug to the underlying strat-

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um of clay — no matter if it be 8, 12, or 15 inches — and 15 to 20 kernels are dropped in the moist soil and covered. Each hole is marked by a stone placed at one side. Occasionally, when moisture is not plentiful, the kernels are placed within a mud ball which is dropped in the bottom of the hole and covered with sand. Sometimes a progressive farmer soaks the seed before planting to secure quicker germination. If a sandstorm fills the holes with sand before the plants are above the surface the farmer will uncover them with his hands. There are often several such storms during a spring.

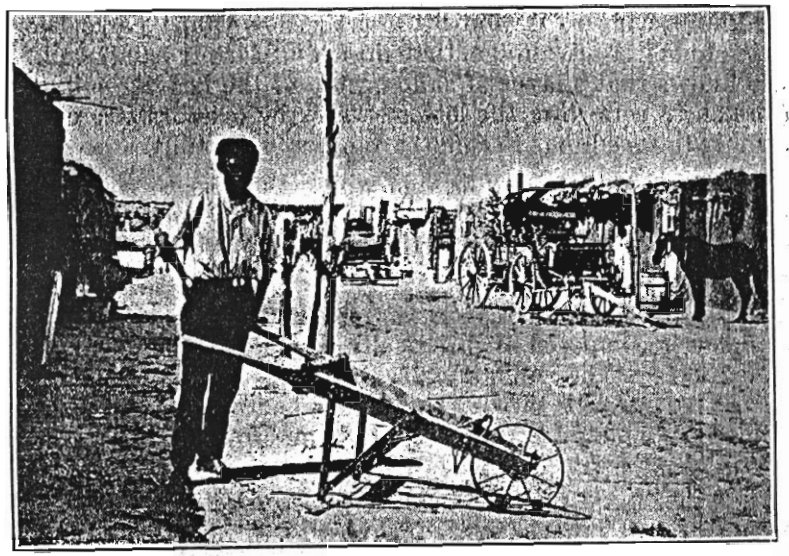

Fig. 1.— Hopi Indian homemade cultivator. This is pulled by one horse and scrapes the weeds from a strip of land about 3 feet wide.

PROTECTING THE CROP

The Hopi has various means of protecting his crops from the action of the wind. One method is to put tin cans from which both ends have been removed over the young plants. After the plants have reached the height of 6 or more inches, the cans are removed, strung on a wire, and hung on the fence to be used the following spring.

Much of the soil is of a very sandy nature, and is, therefore, subject to severe blowing by the winds. During the growing season windbreaks are built across the fields by sticking brush upright in the sand. These windbreaks are located about 30

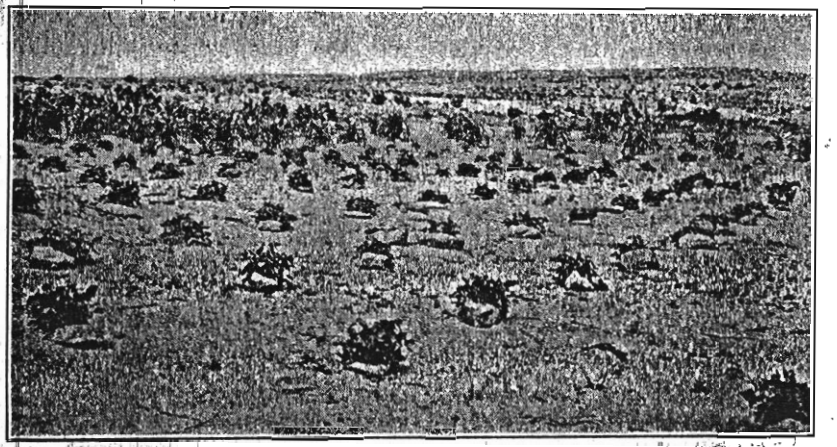

Fig. 2.— A Hopi Indian bean and corn field where each hill is protected with a stone to prevent the plants from being blown out.

feet apart in parallel rows and at right angles to the prevailing winds. Even with this protection, the wind sometimes whips around some hills and injures the plants to such an extent that the farmer places a pile of stones, brush, or weeds on the windward side.

After nursing the crop along by first planting the seed deep, and then uncovering the plants when the sandstorms cover them, the Hopi cannot relax his vigilance, for the crop is never safe until harvested. As the corn grows larger, cutworms cause much trouble. Then the patient Hopi carefully digs around each clump of corn, diligently searching for cutworms. This must be done day after day while the cutworm season lasts or he would raise no corn. He must also guard against the crows. The scarecrows he puts up are so ingenious that they are often mistaken for Indians silently watching the fields.

HARVESTING AND STORING THE CORN

When the Hopi corn is mature, the farmer breaks the stalks over close to the ground, then snaps the ears and carries them to the house on his back or on burros. A few of the more progressive farmers have wagons, but these are of comparatively recent date.

When the corn is taken from the field, it becomes the property of the housewife, and it is her duty to husk and store it. After the ears have been removed, the fodder is cut with a large hoe,

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tied in bundles, and fed to the stock. The mature corn is stored in the house in neat cord-like piles, the blue, white, and yellow ears being piled separately.

The Hopi Indian has found through long experience that dry years come, and that it is always well to provide for them; so the thrifty housewife stores enough corn to tide the family through at least one crop failure.

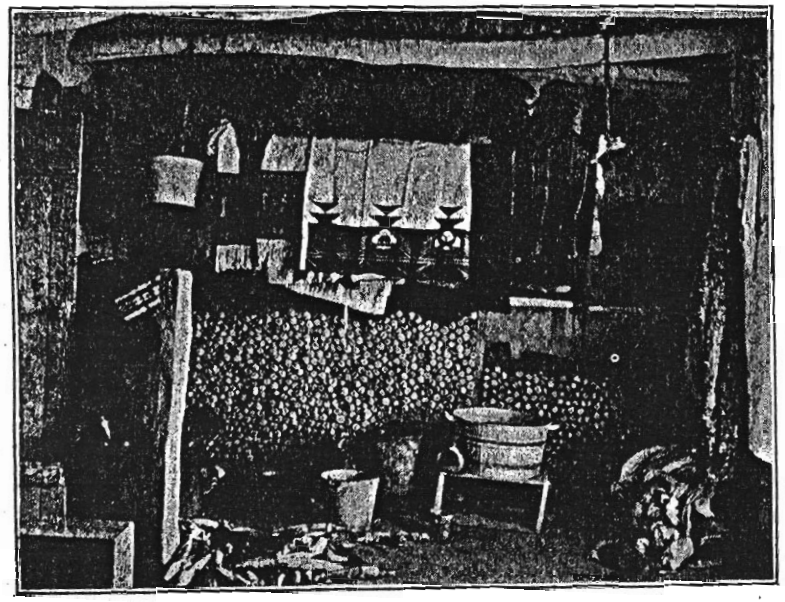

Fig. 3.— Corn piled neatly in a house, the blue and white corn being separate. Note the bundles of dried beans and peppers on the back wall; roasting ears, gourd dipper, and roll of skins on the floor; ceremonial belts and blankets hanging on the rail.

To protect the corn against the inroads of weevils, constant watching is necessary on the part of the housewife. If the weevils are discovered, she calls in her neighbors to assist her, and each ear is carefully inspected for the insects which, when found, are removed by rubbing.

Much green corn is preserved for winter use in the following manner. A shallow pit is dug and thoroughly heated with a fire, after which the embers are removed. The corn, in the roasting-ear stage and with most of the husks left on, is then stacked in, and the opening of the pit is covered completely with leaves and mud, thus making a very creditable fireless cooker. After the corn is cooked it is taken out and all except a few of

the husks removed; these are braided together with those on other ears, and all are then hung up to dry. The dried product is afterwards stored in neat piles or left hanging from the ceiling until needed.

"As soon as the corn is fit for roasting ears there is much feasting at home and down in the fields. The greatest enjoyment of the year comes when the roasting ears are just right. Then the farmer takes his family and invites his friends and they have a wonderful time camping down in the field and roasting the corn in the fire or in large pits in the ground. In the evening, from the mesa top, one can see these camp fires all over the valley. By every camp fire there is a bunch of happy, corn-feasting Hopis. After a week or two of the field camping, the family and friends return to the mesa, fat and brown, and very well satisfied with their pleasant outing." (E. Bentley, *Tucson Citizen*, March 11, 1923.)

HOPI COTTON GROWING

"The fact that cotton was used and of necessity cultivated by the Indians, is recorded by several early Spanish explorers, as it has been more recently by many ethnologists. In the villages of the cliff dwellers of Mesa Verde National Park numerous fragments of cotton cloth have been unearthed, and in Utah seeds of the plant have been found.

"Today, among the Hopi Indians of Arizona, the cotton plant is highly esteemed, and its fibre enters into many of their ceremonies, as well as into many of their household activities. It is considered essential by them that all strings employed in religious services be of native cotton. The strings of cotton are used to bind together prayer sticks and offerings of all kinds and are placed in the trails entering the pueblos where the ceremonial services are in progress. The badges of the chiefs are all wrapped with native homespun cotton strings and cotton is also used to weave ceremonial kilts and wedding blankets.

"Unfortunately the native Hopi, once deft in the art of weaving blankets, mantles, rugs and other articles from cotton, now finds it far easier to purchase either the yarn already spun, the cloth already woven, or the complete garment, and thus the art is gradually being lost. Cotton is still cultivated by them, however to a small extent in a village in the western Navajo Reservation and in another of the Moqui (Hopi).

"The Department of Agriculture has conducted an experiment with Hopi cotton for the past seven years. This particular species of cotton is remarkable for the rapidity with which it

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grows, and the early date at which it blooms, it being the earliest to blossom of several hundred varieties tested. Plants of this species have borne ripened bolls in 84 days from the sowing of the seed." *(Literary Digest* 45, 1009, Nov. 30, 1912.)

Moenkopi is the only place on the reservation where the Indians have grown cotton for any length of time.

BEANS AN IMPORTANT HOPI CROP

Beans are a staple article of food of the Hopis, and practically every field has a portion set aside for their production. There are more than twenty varieties, varying greatly in color, but all of native origin. They have a special variety of small brown beans, from which the green pods are gathered, dried in the house, and used as a vegetable in the winter diet. The farmer is careful to plant, harvest, and store the different varieties separately, but, of course, there is more or less mixing, and when a surplus is to be marketed, the varieties are separated by hand. The threshing is usually done by trampling or flailing. The Indian women will spend many days blowing out the chaff with their breath, often becoming faint from exhaustion.

MELONS AND SQUASHES

Melons and squashes find great favor in the Hopi family. When the first frost comes in the fall, all melons are harvested and stored in the house. These are eaten through the winter as they ripen. They have a native white-fleshed melon which retains its good flavor until January or February. The squashes are cut in rings, hung in the sun, and dried for winter use.

HOPI IRRIGATION

Wherever there is a spring, all possible use is made of the water, and special crops, such as onions and peppers, are planted close together and irrigated by means of small ditches. About half-way down the cliffs of the mesa at Hotevilla, there is a large spring, near which the Hopis have hollowed out a small open reservoir. This reservoir is used to store water for domestic purposes, and the overflow is used on a number of terraced gardens. These terraces are about 4 feet wide and 20 feet long, and so arranged that the waste water from one terrace is utilized in the next one below.

HOPI FARMING AT MOENKOPI

The Hopis at Moenkopi (65 miles north of Flagstaff) and at other places where the Government has developed water for irrigation, have adopted more modern methods of farming, due to closer contact with white men and more or less government supervision. They have horse-drawn implements, such as the plow, cultivator, mowing machine, rake, and, occasionally, a hay-baler.

Under these projects considerable alfalfa is grown, and crops of wheat, corn, barley, and oats are produced in small amounts. The corn is planted in hills spaced about 4 feet apart, and in every fourth furrow, 16 to 20 kernels are dropped into each hill. The farmer, explaining the reason for putting so many kernels in a hill, says that the cutworms, rabbits, prairie dogs, and gophers always destroy a considerable number of the plants, and this large number of kernels is necessary to insure a full stand. If too many plants remain, he thins the hills to six or eight stalks after the plants have become well established.

FRUITS IN THE HOPI COUNTRY

There are a few apricots and apple trees and a great many peach orchards in the Hopi country. The peach was introduced by the Spaniards several hundred years ago and is still propagated from seeds. As a consequence, some of the fruit is very poor, although some is of excellent quality. The Hopi is careful to keep his orchard free of weeds. He believes that when the fruit is bitter and poor in quality, it is because the field was not cultivated and the weeds removed during the fruiting period. A few of the trees are more than 50 years old and still bearing. Each orchard is owned by a single family who cares for it and harvests the fruit. The orchards are always located where the sand is deep, and this is usually at the foot of the precipitous walls of the mesa. These sand-drifts dotted with fruit trees at the foot of the cliffs are a picturesque sight.

The fruit that is not eaten in the fresh state is preserved for future use. In very recent years, the field matrons of the Government have taught the Indians modern methods of canning, but the method of preservation generally used is to cut the fruit in halves and dry it in the sun. Then it must be stored and protected from weevils. Here the Hopi has his own peculiar but effective method. An adobe wall is built 12 to 15 inches from the inside wall of the room and high enough to make a bench or shelf. The dried fruit is placed in the space between the two walls, covered with slabs or rocks or adobe brick and carefully sealed over with mud plaster, thus making an air-tight chamber. Fruit stored in this way is sometimes kept for several seasons in first-class condition.

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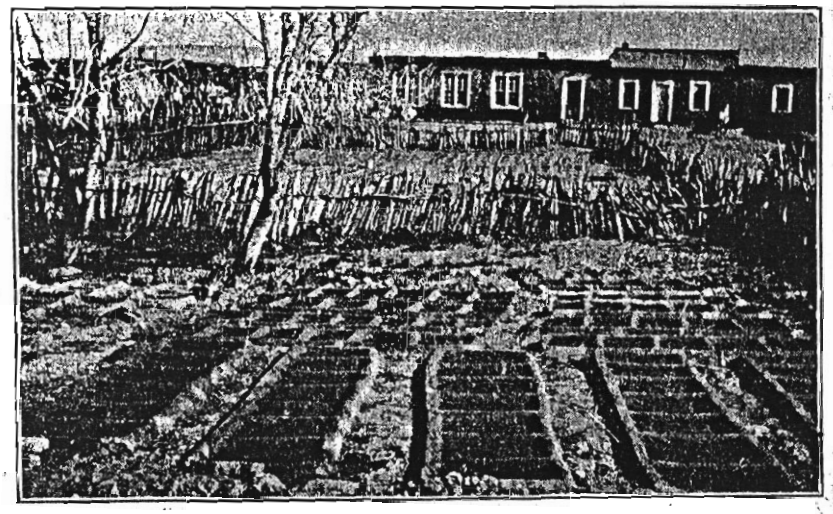

Fig. 4.—The Zuni Indian gardens are divided into many small basins by building narrow borders about 4 inches high. Usually the water to irrigate these gardens is carried a considerable distance in earthen jars on the heads of the women.

ZUNI INDIAN GARDENING

The Zuni Indians living on the boundary between Arizona and New Mexico give a great deal of care to their gardens. In many cases the gardens are divided into small basins, 15 to 24 inches in size, by building up borders about 4 inches in height. From one to six hills of vegetables are planted within each basin, the number depending upon the variety. Frequently the women carry the water for irrigating the garden in earthen jars balanced on their heads.

In some cases the Zunis and Hopis haul sand for their gardens, especially if the soil is a heavy, clay type. Two or 3 inches of sand are placed over each hill after it is planted to conserve the moisture and to keep the ground soft, thus making it easier for the young plants to reach the surface. Instead of sand, the Zuni farmer sometimes uses a reasonably heavy layer of manure. In either case the mulch covers an area of ground 12 or 15 inches in diameter around the plant.

ZUNI LIVESTOCK

The Hopi and Zuni Indians have very little livestock. The foundation stock of the cattle and sheep that they now have was purchased from the Navajos. Occasionally a farmer has a few hogs of no particular breed and of very inferior quality. Considering the number of people on the reservation, there are very

few chickens, and these are of mongrel breed and usually badly infested with insect parasites. The burro, because of its usefulness and its ability to subsist on very meagre rations, is considered by the Hopi farmer a necessary part of his equipment. The population at the present time of the Navajo-Hopi Indian Reservation is about 5,000. The two tribes have about 30,000 cattle, 1,200 burros, 28,200 goats, 6,500 horses, 112,800 sheep, 2,500 chickens, and 110 turkeys. The turkeys are kept for their feathers which are used in the ceremonial dances.

Within recent years beef and mutton have come to be used to a considerable extent in the diet. It is a common sight to see meat hanging on lines across the front of the house, drying in the sun. The dried meat is stored for future use.

THE NAVAJO INDIANS

While the Hopi and the Zuni Indians are home-loving people and build permanent habitations, where they live for generations, the Navajos are a nomadic tribe. They lead their flocks and herds over the desert, wherever the best grass or browse can be found, living in temporary shelters made from cottonwood boughs, sagebrush, mesquite, or any material that may be available. They have, however, a few permanent hogans (houses) built in favorable localities where they live during the winter.

NAVAJO LIVESTOCK

The Navajo's reservation is more or less divided into districts, and the flocks and herds of each family are confined to one division. The foundation stock of the Navajo sheep and cattle was introduced by the Spaniards several hundred years ago. The Navajo herdsman has given very little attention to maintaining or improving the quality of his stock, and at the present time both cattle and sheep are of a very inferior type. This is the natural result of constant inbreeding. There are many black, brown, and spotted sheep in the flocks. In recent years through the efforts of the government agents purebred sires have been introduced and the effects of this pure blood are beginning to show in the improved quality of the flocks.

Each Navajo herdsman has a few goats which are herded with the sheep. The wool, except that which is used for domestic purposes and for making Navajo blankets, is marketed through the Indian traders of the reservation. It is usually of an inferior quality and brings low prices on the market.

The cattle of the Navajos still retain quite a percentage of blood of the original Spanish stock. They are of a more nervous

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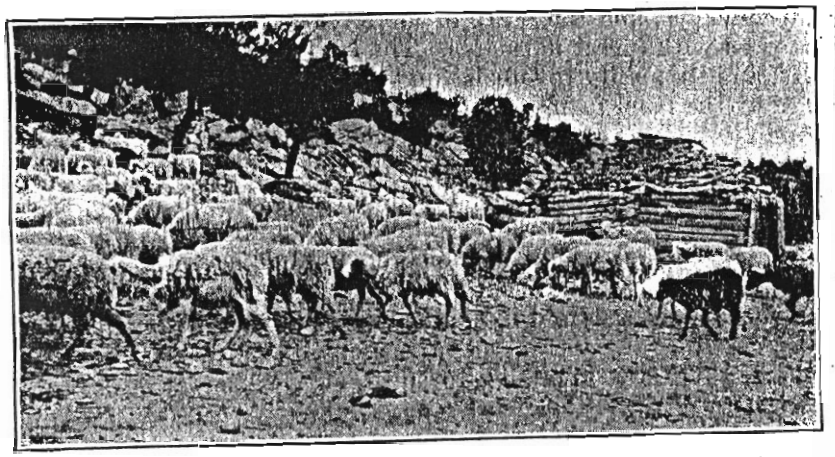

Fig. 5.—A flock of Navajo Indian sheep, and a hogan (house) at the right. The native sheep are of inferior quality including many that are black or brown in color.

disposition and harder to handle than are the cattle of the common white-faced breed.

The Navajo has no definite time or season for marketing his cattle, but whenever he wishes to obtain a little money, he drives a few head off to market. Because of this lack of method, some of the cattle reach an age of 5 or 8 years before they are marketed. The Navajo usually counts his wealth by the number of ponies that he owns, and there are many inferior ponies ranging over the reservation. He seldom sells a pony if he can get money in any other manner.

For generations the Navajos have led a roving, care-free life and have done practically no farming. In recent years the children have been sent away to government schools at Riverside or Phoenix, where, through their work on the school gardens and farms, they have become interested in farming. Upon their return to the reservation, some of them have begun to farm small tracts of their own. The methods they follow are very similar to those of the Hopi Indians.

WEAVING BLANKETS

Navajo women are expert blanket weavers, and, although they receive small recompense for the time and energy expended, the blankets sell for a very good price on the open market. It is interesting to watch a Navajo woman catch a sheep, pull a few handsful of wool from its back, go to her loom, spin the wool, and work it into a blanket.

Fig. 6.—A Navajo Indian homemade cultivator. The Navajos have few farm implements, and these are very crude.

PREHISTORIC IRRIGATION

"The Indians of New Mexico and Arizona had learned the art of irrigating their fields before the appearance of the white man on the continent. This is shown not only by the statements of early explorers, but by the still-existing remains of their ditches. In the valleys of the Salado and Gila, in southern Arizona, however, casual observation is sufficient to demonstrate that the ancient inhabitants engaged in agriculture by artificial irrigation to a vast extent. . . . Judging from the remains of extensive ancient works of irrigation, many of which may still be seen passing through tracts cultivated today as well as across densely wooded stretches considerably beyond the present non-irrigated area, it is safe to say that the principal canals constructed and used by the ancient inhabitants of the Salado Valley controlled the irrigation of at least 25,000 acres." (Hodge in *American Anthropologist*, July, 1893.)

THE PAPAGO INDIANS AND THEIR AGRICULTURE

The Papago Indians, located on the reservation southwest of Tucson, are perhaps the original dry-farmers of southern Arizona. The early records show that they were engaged in dry-

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farming when the first white men visited them several hundred years ago. Many of them are still practicing their primitive methods to a large extent, but some of the more progressive farmers, due to their association with the white man, and to the efforts of the agricultural advisers furnished by the Government, are practicing crop-rotation and using green-manure crops. Many hundreds of acres are planted to crops each year, and when the season is favorable, large amounts of corn, wheat, beans, lentils, and similar drouth-resistant crops are produced. Some of their fields are located where there is a chance to use flood-waters, or where, by the use of temporary dams in the washes, water may be diverted to the lands. Very little cultivation is given after the crop is planted, and as a result there is usually a heavy growth of weeds on the land.

Near the San Xavier Mission, the Government has given considerable assistance in developing irrigation water by installing pumps and by putting in diversion dams in the Santa Cruz River. The Indians here use plows, harrows, and mowing machines. They have a strong community spirit, and whenever the time for plowing, harvesting, or similar operations is at hand, they coöperate in carrying on the work. Frequently six or eight farmers gather to plow a single small patch of ground. The ground is usually plowed dry, the ponies used are small and weak, the Indian is more or less slip-shod in his methods and the net result

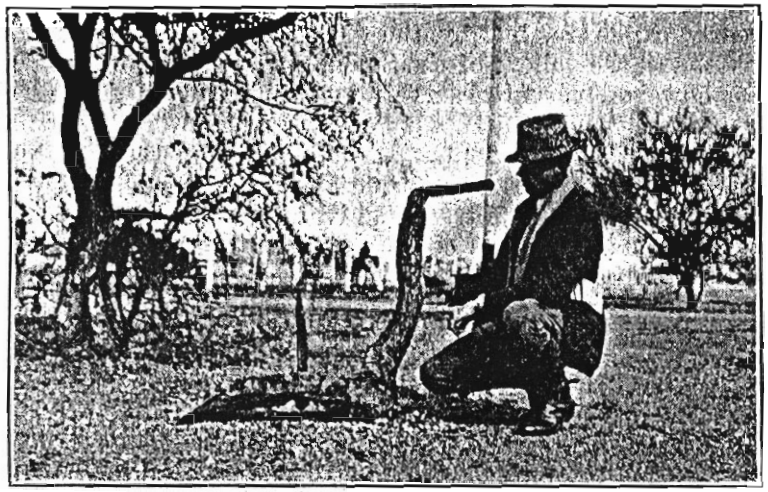

Fig. 7.— Papago Indian plow made from a single piece of mesquite wood. This type of plow was used by the Indians before the steel plow was introduced.

Fig. 8.— Papago Indians coöperating in harvesting wheat with hand sickles. The Johnson grass and weeds are cut later.

is that good plowing is seldom done. There is a great deal of growth of Johnson grass and other weeds in the fields that is not turned under as it should be and the ground is left in a rough condition. After the field is plowed, the farmer sows the wheat by hand and then harrows it in. Occasionally he mixes his seed wheat with wood ashes and scatters the two together. He gives no reason for using the ashes, except to say that "it is good." After the field is harrowed, the ground is irrigated.

Papagos grow mostly Sonora wheat which is very drouth-resistant. Although it does not make good leavened bread, it is used by them for making their native breads.

HARVESTING AND THRESHING THE WHEAT

The Papago methods of sowing and harvesting are similar in many respects to those used in Biblical times. Before the Papago harvests his wheat, he prepares the threshing floor. This is done by throwing up a small dike around an area about 40 feet in diameter, which is flooded, and when dry enough to walk on, it is tamped. The tampers are made from blocks of wood about 8 inches wide and 18 inches long with upright handles. After the ground is thoroughly tamped, a stout pole 15 to 20 feet tall is set firmly in the center of the threshing floor.

The ripened wheat is harvested with small hand-sickles, the

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Fig. 9.—The wheat is trampled out by the ponies as they are driven around and around the pole.

men of the neighborhood coöperating in the work. The Johnson grass and weeds are left standing in the field and later cut with a mower and used for hay. As the wheat is harvested, it is laid in small piles to be gathered up by the men and women and carried on their heads to the wagon. There is usually a man on the wagon to load the grain. It is then hauled to the threshing floor and piled around the pole.

Threshing begins as soon as the harvesting is completed and the wheat is piled on the threshing floor. Several ponies are tied

Fig. 10.—The wheat is winnowed by being thrown into the air, the breeze blowing the light chaff away. The heavier particles of straw are brushed away or later picked out by the women.

closely together by their heads and the head of the inside pony is tied to the center pole by a rope the length of the radius of the stack. A man on horseback drives the ponies around and around the stack, thus trampling out the grain. Two or three men with pitchforks stand on the outside throwing the partially threshed straw back under the ponies' feet.

When the threshing is completed, the grain is winnowed by being thrown into the air. While the men are doing this the women are on their hands and knees with small brushes made of desert growth, brushing to one side the heavier particles of straw that the wind does not remove. When most of the chaff and straw has been removed by winnowing, the grain is scooped up by the women, using native baskets as scoops, put into sacks and carried to the house, where the remaining particles of straw are picked out by hand. Small lots of wheat too green to be trampled out by the ponies are kept separate and flailed out by the women. Care is taken that none of the grain is wasted. When one Indian is more fortunate than his neighbors in raising a crop, he often permits them to do his harvesting and threshing and gives them a portion of the threshed grain for their labor.

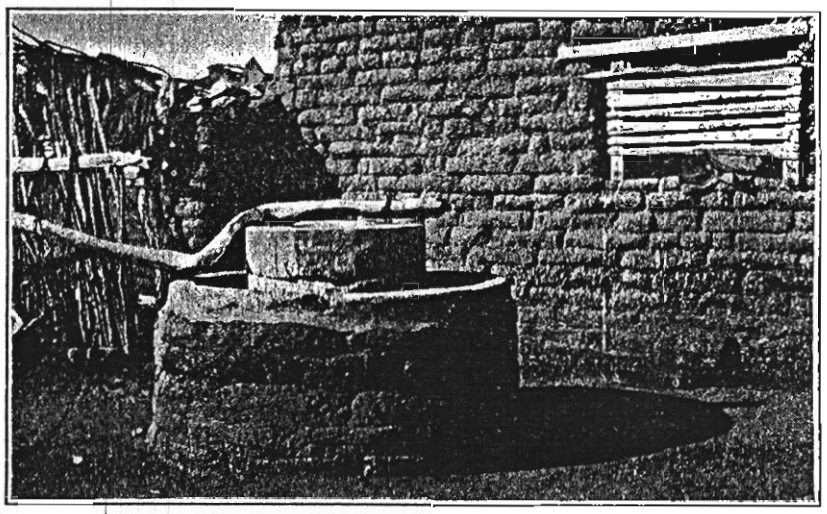

Fig. 11.— Papago Indian custom mill 75 miles southwest of Tucson.

GRINDING THE WHEAT INTO FLOUR

Most of the wheat used by the Papagos is ground with the *metate* and *mano* (grinding stones). A custom mill has been built by the Indians about 75 miles southwest from Tucson. The

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base of this mill is about 5 feet in diameter and is built about 3 feet high of adobe brick. The grinding burrs are made of concrete — one concave, and the other convex. A sweep is attached to the upper burr and it is revolved by a pony. This crude mill is used by the Indians of the community for grinding their wheat and it saves the women many hours of tiresome labor.

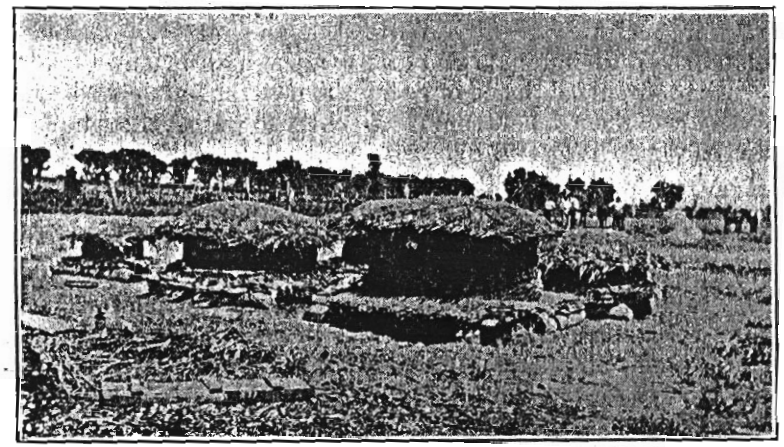

Fig. 12.—The surplus grain is stored in granaries woven from grasses, covered with arrow weed, and weighted down with dirt.

STORING GRAIN

At the present time, when the Papago has a surplus of grain, he constructs a granary out of coarse grass or similar material. This grass is woven into circular containers about 4 feet in diameter and 3 feet in height. After the granary is filled, it is covered with arrow-weed, which is weighted down with dirt.

An ancient and very interesting granary has been found in one of the prehistoric Indian ruins just south of the Arizona boundary line in Chihuahua. The framework of this granary was made of grass twisted in a roll 6 inches thick, and laid in a spiral course from top to bottom. This was plastered inside and out with adobe mud, making a very good storehouse. This granary is about 8 feet in diameter at the base, 12 feet at the widest point and is drawn in to 2½ feet at the top. It was constructed under an overhanging cliff, which furnished excellent protection. A circular opening 18 inches in diameter was located on one side of the base for the removal of grain.

LIVESTOCK OF THE PAPAGO INDIANS

The Papago Indian is unexcelled in the handling of livestock under the semi-arid conditions of the Southwest. He loves his

stock, he studies their habits and environment, and practically living with them as he does, has an opportunity to take good care of them at all times. He is especially fond of his horse and no consideration except the direst necessity, will cause him to part with his favorite mount. Papago Indians, like the Navajos, usually count their wealth by the number of horses that they own, although they may have considerable numbers of cattle and realize that they are actually more valuable. Often the Indians coöperate in caring for their stock, each man taking his turn in the work. By this method they are able to economize in the amount of help required to handle their herds, and those who are not engaged in caring for the livestock are free to grow field crops, engage in hunting expeditions, or do anything else that suits their fancy.

The Papago herder moves his stock from place to place, taking advantage of the local conditions. Practically all the stock are brought down from the mountain areas to the low valleys during the rainy seasons of the summer months. At the close of the rainy season and when the water holes in the lower valleys dry up, they are driven back to the higher lands where the water is still available. Thus during the winter months the higher ranges are used almost entirely. During these periods, it often happens that the Indian is absent from his home for 3 or 4, or even 5 or 6 months at a time. This seems to make no difference to him as he adapts himself quickly to changed conditions, and apparently is as contented following and camping with his flock as when he is located in the village surrounded by his tribesmen.

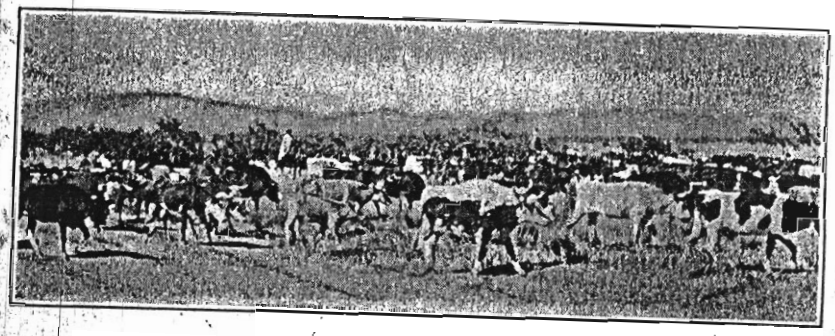

Fig. 13.—Papago Indian cattle. They are of mixed breed and still retain considerable blood of the early, introduced cattle.

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CONCLUSIONS

1. The Indian farmer is very particular to make sure that the soil he farms is deep, that there is a stratum of clay of high water-holding capacity 4 or 5 feet below the surface, and that he can make use of flood water. The white man's ideal dry-farm should have a soil that is deep and of uniform texture and well supplied with organic matter. The farm should be located where there is a chance to utilize run-off water, or where flood water can be diverted from arroyos to cultivated fields.

2. The Indian farmer builds dams across the dry arroyos weeks before local rains begin, anticipating possible flood waters from rains miles away.

3. When the Hopi farmer does not have available flood waters he selects soil of a sandy nature. A loose mulch can be maintained on a sandy soil much easier than on a heavy soil, and a sandy soil retards evaporation better than a clay soil.

4. When the Zuni farmer is forced by circumstances to farm a clay soil he carries in sand or manure for a mulch rather than maintain a soil mulch.

5. The Hopi farmer builds dikes and ditches in his orchard in the fall in order to hold the winter moisture where it is most needed.

6. The Indian farmer makes the greatest possible use of all spring water by raising garden vegetables. Surplus vegetables are dried and kept for winter use.

7. The Hopi housewife dries and stores green beans, peppers, green corn, squash, beans and all surplus fruits to tide the family over at least 1 and sometimes 2 years of crop failure.

8. The Hopi farmer is careful to keep his orchard free from all weeds so that his fruit will not be "bitter." It is a well-known truth among horticulturists that clean culture is essential to the production of good fruit.

9. The Indian has learned that many hands make light work; also that every successful project needs a single directing head, and that all coöperators must support and follow his leadership. They coöperate in plowing, weeding, harvesting, hunting, playing, building, in warfare, and in religious ceremonies.

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EXPERIMENTS WITH SMALL GRAINS IN SOUTHERN ARIZONA

By IAN A. BRIGGS AND R. S. HAWKINS

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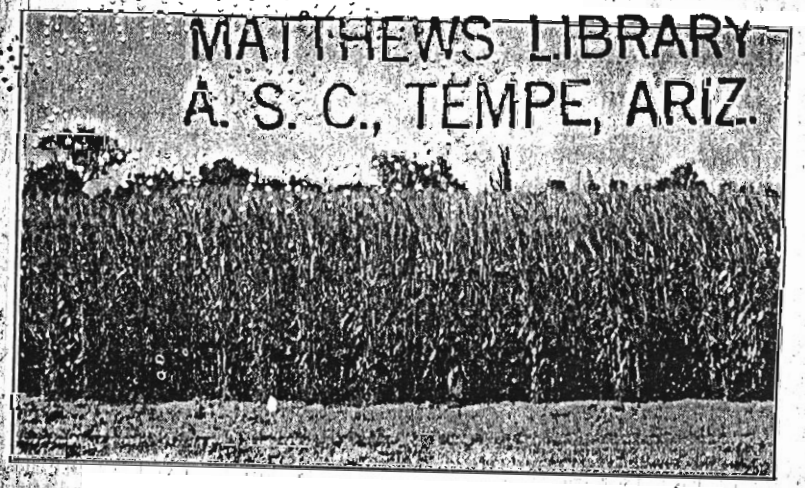

Early Baart wheat. Salt River Valley Experiment Farm.

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