STAIRCASE FARMS OF THE ANCIENTS

Astounding Farming Skill of Ancient Peruvians, Who Were Among the Most Industrious and Highly Organized People in History

BY O. F. COOK

BOTANIST OF THE NATIONAL GEOGRAPHIC SOCIETY—YALE UNIVERSITY EXPEDITION TO PERU IN 1915, AND OF THE BUREAU OF PLANT INDUSTRY OF THE DEPARTMENT OF AGRICULTURE

AGRICULTURE is not a lost art, but must be reckoned as one of those that reached a high development in the remote past and afterward declined, and has not yet recovered its ancient prestige. The system of agriculture developed by the ancient Peruvians enabled them to support large populations in places where modern farmers would be helpless.

The most specialized development of agriculture in the Western Hemisphere was attained, unquestionably, in Peru, and the culmination was reached centuries ago, before Columbus discovered America. Still farther back there must have been a period of slow and gradual development—a period to be expressed in millenniums rather than in centuries. At a time when our ancestors in northern Europe were still utter savages, clothed only in skins, and living by hunting and fishing, settled agricultural communities must have existed in the Peruvian region, perhaps in the same valleys that contain the marvelous remnants of the prehistoric art.

The people who did the finest of the ancient work are not only gone and forgotten, but lack even the distinction of a name. Written records like those of Egypt and Assyria are lacking in Peru, and even tradition has failed to attach names of kings or nations to many of the ancient monuments. Some writers refer to the builders as Megalithic or Big-Stone people, because they used very large stones, like the fabled Cyclopes of the ancient Greeks, who built massive walls and worked in metals. Other writers refer to the ancient Peruvians simply as pre-Incas, because their work evidently belongs to an age farther back than the Inca empire conquered by the Spaniards.

As a race, it may be assumed that the Megalithic people were ancestors of the modern Quichuas, or at least of the same stock, for there is nothing to show that the human type was different in ancient times. In Peru, as in ancient Egypt, it was the custom to mummify the dead and to bury with the mummies the clothing, food, household utensils, weapons, and other objects and articles used by the living.

This regard of the ancients for their dead, together with the dry, equable climate, have made Peru a veritable treasure-house of archaeological material. Not only the skeletons and the other physical features of the ancient people are known, but also the nature and degree of development of all of the arts that could be preserved by burial. The general result of such studies tends to show that the modern Quichuas, the Incas conquered by the Spaniards, and the pre-Inca or Megalithic people were all of the same race and practiced the same arts, including the art of agriculture.

The Incas had a very specialized agriculture, but their predecessors had some of the agricultural arts still more highly developed. They built larger terraces and faced them with larger stones, fitted with wonderful accuracy. The Incas also built extensively, but generally with less skill, or at least with less labor, bedding their stones and plastering their walls with clay, instead of taking the trouble to work down and fit together the huge irregular blocks that characterize the Megalithic period.
Like Egypt in the later dynasties, the Peruvians of the Inca age appear to have declined somewhat from the standard of industry, patience, and perfection indicated by the stone work of the earlier period. In other respects progress may have been made. Thus the Incas may have been better organized and more efficient from the standpoint of government and military activity, as were the Romans in comparison with the Greeks. The modern Quichuas are still an agricultural and pastoral people, but they show no tendency to imitate the constructive undertakings of their predecessors.

STAGES OF AGRICULTURAL PROGRESS

In order to appreciate the high development of the ancient agriculture of Peru, we have to consider briefly the stages that mark the progress of agriculture from the simplest beginnings to the most advanced expression of the art.

In the most primitive form of agriculture, still widely practiced in the tropics, the land is not permanently or continuously occupied. New clearings are made every season by cutting and burning. Corn is planted and harvested, and then the forest growth is allowed to spring up again. This nomadic system of annual cornfields, or milpas, as they are called in Central America, is practiced in all tropical countries of low elevation.

Tillage agriculture is the next stage. In order to use land for more than one season, tillage is necessary, at least to the extent of stirring the surface soil and destroying weeds, so that seeds can be planted.

A third stage is reached when tillage agriculture is improved by the application of manure, fish or seaweeds, or by using decayed vegetable matter or "green manure" to increase the fertility of the soil. Another step beyond tillage, with or without the use of fertilizers, is irrigation—the artificial application of water to the soil. Irrigation must have begun in regions where it was easy to supplement the natural rainfall by diverting streams, as in the steep mountain valleys of Peru.

Doubtless all of the preceding forms of agriculture were represented in Peru in ancient times, as they are at the present day; but they must have had relatively little importance in comparison with a type still more advanced—a type quite unknown to the American farmer and scarcely to be seen in the United States, except to a very slight extent in ornamental grounds. This most specialized type of agriculture includes all of the preceding features—tillage, fertilizing, and watering the crops; but another is added—the artificial construction of the soil on which the crops are grown. In the valleys where the ancient Peruvian agriculture was centered, most of the agricultural land is not natural soil, but has been assembled and put in place artificially (see also page 494).

MARVELOUS TERRACE AGRICULTURE

This most specialized type may be described as terrace agriculture, and is seen in its most conspicuous form when narrow terraces are built on steep slopes. Such terraces are found in many other countries, though it is doubtful whether any equal those of Peru. In Peru the artificial reconstruction of the soil surface was not limited to the terraced slopes, but was also undertaken in large areas of reclaimed land in the bottoms of the valleys. The courses of the rivers were narrowed and straightened by strong walls, and then the land behind the walls was filled in, and finally a surface layer of fine agricultural soil was put on.

The entire region that represents the chief center of the Inca empire and its Megalithic predecessors affords very little of the level or gently sloping natural soil that we would consider well suited to agriculture. Most of the level land is on the high plateaus, where the climate is too cold or too uncertain for the growth of crops, so that planting is confined largely to the slopes to avoid the danger of frosts in the growing season.

To us in the United States this laborious construction of the artificial lands in the warmer valleys seems almost incredible. Even irrigation agriculture appears to us as a new and very specialized branch of the art, and we think ourselves very enterprising to have undertaken the
reclamation of our so-called "deserts" in the Western States, where wide expanses of nearly level and very fertile soil have been made richly productive simply by being supplied with water. The native agriculture of Peru reached the stage of reclamation projects long before America was discovered by Europeans. Our undertakings sink into insignificance in the face of what this "vanished" race accomplished. The narrow floors and steep walls of rocky valleys that would appear utterly worthless and hopeless to our engineers were transformed, literally made over, into fertile lands, and were the homes of teeming populations in the prehistoric days. That the work was well done there can be no possibility of doubt, for many thousands of acres of these artificial lands are still fertile and are the chief support of the modern population of the valleys. The native people take the amazing works of the ancients as a matter of course, as we accept the natural features that surround us, and are no more inclined than we are to such impossible undertakings as the ancient people accomplished. That the ancient people should have taken to terrace-building is not difficult to understand in the presence of the natural conditions where the art developed. With an agricultural population becoming crowded in steep, rocky valleys, the removal and piling up of the stones to give more room for plants would be a most natural step for a primitive people to take. In the early days the building of terraces may have appeared simply as an effective way of disposing of the stones and leaving the largest area of tillable land after the work was done. If there were more stones than could be used in building the walls, the surplus could be disposed of by placing them behind the walls to form a porous subsoil for the surface layer of fine earth where the crops were grown. More land could be cleared by building the stones into walls than by merely throwing them into piles. The desirability of piling the stones or building the walls so that they would hold the soil in place and prevent washing would also become apparent.

The most strikingly artificial feature of the ancient Peruvian agriculture was the covering of steep slopes with narrow terraces, supported by stone walls and watered by aqueducts built for many miles along the precipitous slopes of the mountains. Some of the terraces, those that characterize the Megalithic Age of Peru, were built of enormous stones, often of very irregular form, fitted together with wonderful nicety. The labor expended in the construction of these terraces shows that they served some purpose that the builders considered very important. We learn from the early Spanish historians that the Incas had special gardens for raising the potatoes of the royal household, and that there was a general belief among the people that the growth of crops and the fecundity of the flocks were acutely dependent upon the welfare of the royal family. Hence there was an underlying practical reason for the deep solicitude of the people, so often remarked by the early historians, "That it might be well with the Inca".

**COMPARED TO THE HANGING GARDENS OF PERU, THOSE OF BABYLON WERE INSIGNIFICANT**

The hanging gardens of Babylon have long been reckoned as one of the wonders of the Oriental world; and yet they were a mere transient toy and for 3,000 years have been only a tradition. The hanging gardens of Peru, though of unknown antiquity, are still in existence, and doubtless as worthy of our admiration as were those of Babylon in the days of Herodotus and Strabo. The Babylonian gardens are said to have been 400 feet square and as high as the walls of the city, variously stated at from 75 to 300 feet. The structure had the form of a pyramid, with broad steps, on which earth was placed for the growth of plants. No doubt such an artificial hill was a striking object in the plain of Babylon, and gave Nebuchadnezzar's Median queen a pleasant reminder of her mountain home, where, it may be, there were valleys with terraced slopes as in Peru.

Many banks of terraces in Peru are very much longer and very much higher
MT. VERONICA, 20,000 FEET HIGH, THE URUBAMBA RIVER, AND THE MAIN VALLEY ROAD

A portion of the pack train of the National Geographic Society-Yale University Peruvian Expedition of 1915 in the foreground.
THE GRAND CANYON OF THE APURIMAC

A bit of the Apurimac Valley between La Estrella and Abancay. If the Pan-American Railway is ever completed, one of the most interesting sections and one involving tremendous engineering difficulties will be in this immediate vicinity, where the road from Cuzco to Lima crosses this magnificent tributary of the Amazon.
AN ARTIFICIAL WATERFALL CONNECTING TWO ANCIENT IRRIGATION DITCHES IN THE HIGH COASTAL DESERT OF SOUTHWESTERN PERU

Numerous irrigation channels were carved along the steep mountain slopes, often for long distances. The courses of rivers were straightened, and many square miles of artificial land were constructed in the bottoms of the valleys with an expenditure of labor almost inconceivable.
THE NARROW RIDGE ON WHICH MACHU PICCHU IS SITUATED AND THE MAGNIFICENT URUBAMBA CANYON

A distant view of Machu Picchu on its narrow ridge, flanked by precipices, in the most inaccessible corner of the Andes, in the heart of the Urubamba Canyon. The sharp peak in the right foreground is Machu Picchu Mountain. The lower conical peak at the extreme left is Huayna Picchu. The city of Machu Picchu is on top of the ridge between these two peaks and almost directly underneath the little fleecy cloud which hides part of a distant mountain.
The people of Pre-Columbian Peru had more than sixty species of plants under general cultivation, with half as many more under local cultivation. No other part of the Americas equaled this record. Peru was the chief center of plant domestication in the New World.
WHEAT AND BARLEY FIELDS ON THE SLOPES ABOVE THE URUBAMBA VALLEY

Across the middle of the picture runs one of the great highways of the region that has its center in the city of Cuzco.

The culture of the Incas may be said to have resulted largely from their success in domesticating the alpaca and the llama. They were domesticated so long ago that no wild members of the species remain. Using hundreds of thousands of beasts of burden capable of carrying from fifty to one hundred pounds apiece, the Incas were able to carry out their splendid engineering and agricultural work.
ONE OF THE HIGHEST AGRICULTURAL CANALS IN THE WORLD

The rich bottom lands of this elevated valley were desired by the Incas for growing potatoes. Accordingly, the meandering stream was straightened and enclosed so as to prevent it from occupying any more land than was absolutely necessary. It is in the upper valley of the Pampacahuana, a tributary of the Urubamba, and is at an elevation of 12,800 feet. Potatoes are still raised on the slopes of this valley at an elevation of slightly more than 13,000 feet.
We are able to get a glimpse of life among the ancient Incas through the part of their vocabulary that has come down to us. They had different expressions to denote all the degrees of drunkenness, which shows that they had no prohibition; the absence of words for buying and selling shows that money was unknown; the fact that they had a single word to denote "enemy" and "soldiers" would indicate that they must have been "peace-at-any-price" people.
A ROADSIDE SCENE IN THE CENTRAL URUBAMBA VALLEY

The rim of this valley is from 6,000 to 10,000 feet above the river, and from 16,000 to 20,000 feet above the level of the sea. In these remote regions a llama can be bought for three dollars, a sheep for thirty cents, and a llama-load of firewood for twenty cents.
PLOWING TIME IN PERU

The sons and daughters of the Inca race may still survive, but their blood has outlasted their civilization.
A TYPICAL PERUVIAN PLAZA

The llamas are loaded with rock-salt. The open sewer in the center of the street is characteristic of most mountain towns.
PLOWING IN THE CENTRAL ANDES

The plowman is a Peruvian mountain Indian. His oxen are descendants of the imported European stock; his plow is an iron tipped, pointed stick such as his ancestors have used since the Spanish Conquest. The scene is laid in the Urubamba Valley. The chief crop is Indian corn.
OUR CARAVAN CROSSING THE COASTAL DESERT AT AN ALTITUDE OF 15,000 FEET: MT. COROPUNA IN THE BACKGROUND, ELEVATION 21,703 FEET
A MULETEER'S STORE IN AN ARCADE ON THE GREAT PLAZA OF CUZCO

Here is exposed for sale everything that appeals to the eye and the pocketbook of the Peruvian muleteer. Richly decorated halters, leather knapsacks in which to carry his coca or other valuable articles, and even flutes to while away the weary hours of his journey are here displayed.
As soon as they are able to walk the little Indian children of Peru are set to work. They are early taught to collect firewood and forage wherever they can. They have no toys and live a playless childhood. It is not an uncommon sight to see a little three-year-old girl driving home a sheep loaded with small branches which she herself has collected for firewood.
than the Babylonian wonder. A bank of 50 terraces 10 feet high means a vertical height of 500 feet. Many slopes have more than 50 terraces, forming huge staircases as high as the Washington Monument, resting against the lower slopes of mountains that tower for thousands of feet above. It is only by taking the ancient works out of their natural setting that we can appreciate their gigantic proportions.

**AN AMAZING SPECTACLE**

In the days when they were built, the hanging gardens of Perú must have presented an amazing spectacle. All of the terraced valleys, with their teeming populations, were probably as clean of trees and shrubby vegetation as some of the valleys still are, where people have continued to be too numerous to permit of reforestation. Thus the terraces must have stood out in much greater prominence than they do now, when most of them are abandoned and overgrown with grass and bushes. In some of the valleys in the vicinity of Ollantaytambo reforestation is well advanced and the terraces now support large trees.

**THEIR MEMORIALS TO THE GREAT WERE AGRICULTURAL TERRACES INSTEAD OF TOMBS**

The building of terraces was developed into a fine art in Perú. The skilled labor that was lavished in ancient Egypt on the tombs of the sovereigns appears to have been applied in Perú to the construction of gardens of special workmanship for raising the food of the royal family. The ancient Peruvians made burial structures for the mummies of their dead, but the chief concern was for the living. The tombs were of modest proportions and were placed in caves or set high on the rocky cliffs in the mountains, not in locations suitable for agricultural purposes. Pressure of population afforded, no doubt, the underlying compulsion to go forward with the construction of the agricultural terraces, and at the same time tended to develop skill and emulation. The natural interest in the permanence of one's work, the desire to do it well, and the wish to have it appear to advantage, doubtless were motives that spurred the ambition of the prehistoric masons, as of artists of the present day. The terraces are beautiful, not only because the stones are finely dressed and nicely fitted, but because the work is fully in keeping with its surroundings and admirably adapted to its purpose. The function of a terrace wall is to stand and hold the soil. Thousands of the ancient terraces have stood through the centuries, and the soil that the ancient people laid down is still in place.

The work that the prehistoric builders accomplished is still beyond our comprehension. Nobody has explained how it was done or how it could be done. Indeed, the modern Indians deny that it ever was done, preferring to believe that it was the work of enchantment. Huge rocks that could have been moved only with the greatest difficulty and by the combined labor of hundreds of people are nevertheless fitted together with incredible nicety. To say that there are seams too fine to insert knife-edges or tissue papers leaves the story only partly told. There is no room for inserting anything, since the surfaces are actually in contact. With some of the finest work, at Ollantaytambo, the joints are in many places too fine to be seen by the naked eye. A lens becomes necessary to make sure that there is really a seam and not merely a superficial groove, or false joint. Professor Bingham compares the fitting of the stones to the grinding of glass stoppers into bottles, which is the best analogy thus far suggested. But how can anybody credit the idea of grinding together with such accuracy the edges of stones that weigh tons? Obviously the edges must have been ground before the stones were put in place. But the grading in itself does not seem so difficult to explain as the shaping of the stones with such accuracy that the ground edges fit so absolutely together.

**THEIR MASTERPIECES WERE GARDENS INSTEAD OF FORTRESSES**

That the masterpieces of the Megalithic art have been described hitherto as fortresses instead of as gardens only shows how far our own race is from appreciat-
ing the devotion of the ancient people to their agricultural pursuits. From the nature of their undertakings it is plain that in those days agriculture had the highest consideration. Nothing that human labor could accomplish was too much of an honor to be paid to the art that enabled these ancient people to create for themselves the essentials of a civilized existence, even under very unfavorable natural conditions. Notwithstanding the enormous labor expended upon the building of ordinary terraces, such work was carried far beyond the practical necessities and brought to a stage of perfection that compels us to wonder as well as to admire.

In some respects even the finest of the walls appear very rude, but for that very reason they bear the more overwhelming testimony to the remarkable perseverance of the builders. In what other way could a primitive people have left so convincing a testimony of their attainment of the condition of an ordered society? The people who carried through these undertakings had not only solved the problem of existence and of food supply, but had developed very high standards of artistic perfection, along with the energy and patience to carry them into execution under natural conditions of extreme difficulty and with none but the simplest of tools.

The development of terrace-building into a fine art would follow naturally after the terrace system of agriculture came to be widely used. No people capable of such perseverance in the building of terraces would fail to take pride in their walls, as masons have done ever since. From the very foundation of Rome we have the tradition that Romulus killed Remus in a quarrel over the construction of a wall.

In Peru the building of walls for terraces came in advance of walls for houses or towns, and we may believe that the builders of the finest terraces received the highest appreciation. Building the terraces in more difficult places and making them of harder and larger stones, joined with greater and greater skill, would be natural steps in the development of the art, like the larger and larger pyramids of the successive Egyptian pharaohs. Indeed, when all the conditions are taken into account, it is difficult to imagine any other kind of work in which skill would be so likely to be developed and applied as in the building of these terraces.

THE STRUCTURE OF THE TERRACES

That the terraces, including those of the finest construction, were built for agricultural purposes is obvious as soon as their internal construction is taken into account. Each terrace consists, roughly speaking, of three parts—the wall and the two distinct layers of earth that fill the space behind the wall. All of the ruined terraces show the same inside structure, wherever the walls are removed. The strata that are hidden behind the walls are artificial no less than the stone facing (see page 509).

The underlying stratum, or artificial subsoil, is composed of coarse stones and clay, and is covered by a layer of fine surface soil two or three feet thick. The thickness of the subsoil layer depends, of course, upon the height of the terrace. Where clay or other light-colored material is used for the subsoil, the difference between the two layers appears most striking; but the finer texture of the upper layer also renders it very distinct (see page 508).

In height the terraces range usually from 8 to 14 feet, the width depending upon the slope. Terraces on very steep slopes or narrow shelves of rock are sometimes only 3 or 4 feet wide, though the usual range is from 8 to 15 feet, or still wider on the more gradual slopes. Banks of 20 to 30 terraces are not uncommon, while 50 or more are found in many cases.

That some of the stones and soil for building the terraces was carried by llamas is not impossible, but does not seem very probable. Most of the terraces are at elevations below 11,000 feet, while llamas are used chiefly in the higher altitudes. Probably most of the soil was moved in baskets or mats carried on men's backs.

There is a tradition that earth for the Inca garden at Cuzco was brought from a special place near Quito, some 700 miles
Some of the stones have been torn away near the corners of the terraces, and the upper layer of fine agricultural soil is partly exposed. The row of niches in the upper terrace may have corresponded to a row of windows in an outer wall, thus inclosing a long passage or corridor, with a doorway at either end, of which one remains (see page 438).
away. This may be taken at least as an indication that soil was carried sometimes for long distances, and in such cases it probably was transported on pack animals.

**THE WATERING OF THE TERRACES**

Water was brought to the terraces from the slopes above in artificial channels or acequias leading down, often for many miles, from the gorges of the high mountains, where they intercepted perennial streams fed by the melting of the glaciers and snow-fields (see page 504). Careful provision was made to avoid erosion of the soil or injury to the walls.

Three different methods of bringing the water down from one terrace to another are to be seen about Ollantaytambo. Some terraces have narrow vertical channels near the ends of the retaining walls. In other banks of terraces the water was brought down over large upright stones and caught in a basin below.

The third method was to carry the water down along the walls at the ends of the terraces, which were set with double rows of stones to form the water channel between.

Long banks of terraces are interrupted at intervals by passageways that doubtless served the double purpose of roads for reaching the terraces and of drainage channels to bring down surface water from the slopes above, and thus avoid the danger of having the terraces washed away by heavy rains.

The handling of the water on the terraces undoubtedly was greatly facilitated by the fact that the soils in all the terraced districts are extremely tenacious and not readily eroded. A few sods or a small ridge of earth will hold in check a stream of water, even with a swift current.

**THEY PROBABLY HAD SHOWER-BATHS**

A special feature in terrace watering was indicated at Machu Picchu, where many large stones, deeply grooved lengthwise, lie scattered along the terraces. Such stones might have served as spouts to carry the water out from the terrace wall, and thus avoid still further the danger of erosion or undermining of the wall.

The idea of hanging gardens watered by small streams or jets falling through the air affords an attractive possibility in the existence of the ancient people. Conducting the water down over the terraces in this way would afford ample shower-bath facilities for the people who worked on the terraces. Let us at least cherish the hope that the so-called "baths" found in the ruins of Machu Picchu and elsewhere were not merely basins where water was dipped up in jars, and that the ancient people were not so deficient in ideas of bodily cleanliness as their modern descendants. Ethnologists are familiar with the fact that the introduction of European clothes has tended in many countries to destroy habits of cleanliness among primitive peoples.

**A LAND-STARVED PEOPLE ACCOMPLISH THE INCREDIBLE**

Some of the most laborious terracing is not on the steep slopes, where the terraces are high-walled and narrow, but in the bottoms of the valleys, where the terraces are often very broad. The building of broad terraces required more labor because it involved the filling and leveling of much larger areas behind the walls. Much of the work could have been avoided by making larger numbers of lower and narrower terraces, but the walls would have been more numerous and would have occupied more of the surface.

With labor very abundant and land very scarce, the ancient engineers followed the plan of making the terraces as broad as possible, sometimes even to the extent of bringing material and filling in behind walls 15 or 20 feet high. Thus it would be very conservative to estimate that the building of the broad, valley-bottom terraces involved the handling and replacing of the earth for an average depth of at least 6 feet over the entire surface. This allows 3 feet for the surface layer of fine soil and at least an equal depth for the subsoil layer.

The labor would depend, of course, on how far the material had to be carried. Some of it may have been moved only a few feet, some a few yards or rods, but some must have been brought for considerable distances, as when areas of cul-
SOME OF THE STAIRCASE FARMS OF THE ANCIENTS

Each terrace consists of three parts—the wall and the two distinct layers of earth that fill the space behind the wall. All of the ruined terraces show the same inside structure, wherever the walls are removed. The strata that are hidden behind the walls are artificial no less than the stone facing (see also illustrations, pages 508 and 509).

The underlying stratum, or artificial subsoil, is composed of coarse stones and clay, and is covered by a layer of fine surface soil two or three feet thick. The thickness of the subsoil layer depends, of course, upon the height of the terrace. Where clay or other light-colored material is used for the subsoil, the difference between the two layers appears most striking; but the finer texture of the upper layer also renders it very distinct. The lower terraces of this bank are still under cultivation. In the background a part of the megalithic terraces can be seen. A ruined Inca house stands near the base of the precipice at the left.

tivated lands were widened by building new terraces along the beds of the streams.

In many cases the work was evidently planned so that large immovable boulders or outcrops of rock could be utilized in the building of the walls instead of being allowed to diminish the area of cultivated land. We may believe that powder or dynamite, to shatter refractory rocks, would have been very highly appreciated among the ancient Peruvians.

STRAIGHTENING OF RIVER BANKS AND STREAM BEDS

It would be a mistake to suppose that reclamation work in the bottoms of the valleys was wholly or even principally of the nature of improving irregular land by terracing and leveling behind the walls. A large part of the surface of the valley bottoms must have been altogether bare of soil, as the unimproved portions still are—mere wastes of loose stones brought down by the torrential floods.

The natural behavior of swift mountain streams is to cut irregular channels back and forth between the walls of their valleys, but in the terraced valleys of Peru it is the regular condition to find the rivers and smaller streams confined to channels of definite width, and sometimes kept in straight courses for several miles at a stretch, as in the case of the Urubamba River near Pisac, and again below Ollantaytambo. In the latter instance the river runs for nearly five miles in a straight course, and, although the ancient walls that were built to confine the river have remained intact in only a few places, the artificial nature of the channel is obvious.
A road that runs along the river has utilized the top of a buried wall as a pavement. These buried walls, which occur also in other places, make it evident that narrowing of the channel of the river was accomplished by gradual stages. In this case the area of cultivated land was widened for about 12 feet toward the river by building a new wall closer to the river and filling in behind it. The old wall was left in place, but buried in the mass of the terrace and covered with earth so that it did not interfere with the cultivation of the land. Thus the land-starved people gained an additional strip of land, only a few feet wide, but several miles long. The river may have furnished the stones for the new wall, but the layer of surface soil must have been brought from a distance.

These ancient Peruvians built aqueducts that are unequalled elsewhere.

The ancient aqueducts of Peru have challenged the most attention from former travelers, and they do not become less worthy of admiration because they are now seen to be only one feature of a highly specialized agricultural system. The construction of the irrigation channels was an enormous undertaking, perhaps not equaled in any other part of the world. From the aqueducts alone it is evident that agriculture must have attained a high development, which may explain why the other branches of the art have received less consideration.

How numerous and extensive the ancient aqueducts really were may never be known, but the subject is worthy of much more extensive study than it has received thus far. If the accounts of early Spanish writers are to be accepted, some of these aqueducts were very long. Garcilasso wrote of one of them as 55 leagues long and another 120 leagues, with a depth of 12 feet.

Where the soil was loose the channels were paved with stones for many miles. On rocky slopes or precipices channels were cut into the cliffs, and in some cases tunnels of considerable length are said to have been drilled.

Where channels were being carried along the sides of steep slopes, the usual method of passing vertical surfaces or overhanging rocks was to build up a wall from below to the height of the channel. In sheltered angles such walls remain in place after the channels that ran along the exposed slopes have entirely disappeared.

Where squashes are tied

The favorite courses for the ancient irrigation channels, and by far the best from an engineering point of view, were along the very crests of the ridges and spurs of the mountains. In such places the water-courses were cut, and now have worn deep grooves. Thus there is no danger of the channels washing away or being filled up by drainage from above, as with channels that run along the slopes (see page 517).

Cultivation was by no means confined to the walled terraces that usually follow the lower slopes of the mountains, but was carried all the way up, on any slopes that were not too steep to permit the accumulation of soil. It was not necessary to build terraces to get rid of rocks on slopes that are so steep that rocks roll off. Slopes are even now cultivated where squashes have to be staked or tied to keep them from rolling down the mountain, and where potatoes must be picked instead of being shaken from the vines. As these higher slopes are cool and cloudy, there is much less need of irrigation than in the valleys below.

Though stone terraces were seldom built on the high slopes, a system of narrow earth terraces or transverse ridges, somewhat analogous to the contour farming in our Southeastern States, was in general use. Remains of such ridges cover large areas of the higher slopes. Usually there are a few large ridges at intervals, with numerous smaller ridges between. Many of these smaller ridges can be seen from the valleys below only when the light comes from a particular angle, so as to cast shadows across them. When lighted from in front the inequalities are not shown, and nobody would suspect that such steep slopes, now producing only a sparse and scattered
TERRACES ON NARROW SHELVES

In addition to the terraces of regular form built in banks, any irregular shelf of rock that would support a wall was likely to be used as an agricultural terrace. In this case the shelves were so narrow that the terraces could have been only three or four feet wide—hardly room enough for more than one row of potatoes.
growth of bunch grass, were once cultivated (see illustration, page 511).

In one place just below Urcos a narrow strip between broken precipitous rocks is covered with short transverse ridges like a stairway.

The areas that have been farmed in this way are very extensive, much more so than the lands that are still cultivated in the valleys below. A few of these high slopes are still cultivated, but most of them have been abandoned. Where the lands are now used by the Indians, the same system of transverse ridges is employed. The larger ridges at intervals have the effect of preventing, or at least impeding, erosion. These ridges are not cultivated, but are left in grass, and thus serve to let the water run down the slopes without allowing it to cut channels, thereby having the function of spillways or “drops” in irrigation systems.

EVEN THE GLACIERS RETREATED BEFORE THEIR INDUSTRY

Riding for many hours, or even for days, through valleys where all of the upper slopes show signs of having been cultivated in former times, and very few are cultivated now, eventually gives one an almost oppressive feeling of the past that has vanished long since, and yet is so ever-present that the eye can scarcely avoid it, even when one looks up to the glaciers and the eternal snows. The people who grew potatoes on the high slopes must have stood in their day against the same icy background. Indeed, their agricultural activities may have driven the very glaciers back, by gradually clearing the mountain slopes and exposing them to the sun, just as they narrowed and straightened the river torrents by hemming them in with successive walls of rock.

That the glaciers formerly extended much farther down is shown by the positions of the moraines. There can be little doubt that the whole aspect of the country has been altered profoundly during the very long period of intensive agricultural occupation. Biologically speaking, there is every reason to believe that most of the cultivated lands had a forest covering originally, and that the present state of denudation is largely artificial. Remnants of a native forest flora are still to be found in places too rocky and broken to be cultivated, even by the strenuous methods of the ancients.5

A RECLAMATION AGRICULTURE

From the facts already stated, it is apparent that the ancient agriculture of the interior valleys of Peru was to a very large extent a reclamation agriculture—that is, an agriculture involving community organization and planning in advance. Only a very small part of the land that was used was naturally adapted to the raising of crops. Much of it was too dry to grow crops without irrigation, and even more of it was so steep or so rocky that the surface had to be terraced or otherwise reformed in order to make it suitable for cultivation.

Of the four forms of reclamation that were so extensively employed in ancient Peru not one has been used, or even seriously considered, in the United States. Nowhere do we cultivate steep lands like the higher slopes of the Peruvian valleys, or build stone walls to support narrow terraces, or place artificial soil on broad terraces in valley bottoms. In a few places we are beginning to straighten and confine our rivers to make more land along the banks, but chiefly with the object of preventing floods or reclaiming broad, level lands by drainage, not with the idea of building new lands in the rocky beds of torrents, as in Peru.

COOPERATION FOR THE COMMON GOOD

Primitive the ancient Peruvians were in many ways, as their modern Quichua descendants still are; but with respect to agriculture and some of the attendant arts a very high state of development must have been attained and at a remote period. Otherwise it would have been impossible to occupy and reclaim many of the places that evidently were centers of population in ancient times.

Many localities must have been treated as reclamation projects from the very

*For a more detailed treatment of these matters, see "Agriculture and Native Vegetation in Peru", Journal of the Washington Academy of Sciences, Vol. VI, pp. 284-293.
WHERE THE CROPS OF THE INCAS WERE STORED

Storehouses represent a very specialized branch of Inca architecture. A long, narrow building, with one wall much higher than the other and a curious half-gable roof tied to projecting stones, typifies this kind of structure. The width of these storehouses inside the walls is usually less than eight feet, and many of them are built in small sections, which are nearly square. The one shown in this photograph was about 28 feet long and 25 feet high. The walls are about 30 inches thick, of stones laid in clay and stuccoed with clay mixed with grass. The unusual height of the building, the arrangement of the windows, and the lack of any indication of an upper floor argue against its use for human habitation. It is far more likely that this type of house was built for the specific purpose of a granary or storehouse.
TERRACED VALLEY BOTTOM AT OLLANTAYTAMBO

All the open fields are broad, artificial terraces. A large aqueduct or causeway, about a mile long, carried on walls 15 to 30 feet high, seen in the middle of the picture, crosses the valley in a nearly straight line. A part of the town is seen in this view from the northern bank of elevated terraces or hanging gardens. In the lower right-hand corner is the end of the projecting ridge that carries the hanging gardens. The town is surrounded on three sides by large agricultural terraces (see pages 438 and 440). The valley at this point is about a mile broad and overhung by steep mountains about a mile high. Several banks of terraces, their true size dwarfed by the mountain above, can be made out along the base of the rocky slope. This view is from the slope above the hanging gardens.
first. They could not have been occupied in any desultory way by colonists or settlers acting separately as individuals. This is plain from the natural conditions and from the nature of the work that had to be done before the crops could be grown to support the colonists.

In many places the aqueducts afford the only permanent supplies of water for human uses as well as for the irrigation of crops. Deliberate planning is also shown in the placing of the aqueducts and terraces, and in the regular way in which the lands of the ancient reclamation enterprises were laid out. Large areas appear to have been developed as units, on the basis of carefully considered undertakings. If the valleys had been settled first by unorganized individuals, at liberty to take lands where they liked, the most favorable places, where the lands were nearly level, would have been occupied first. The tendency would have been to pile up the stones around the boundaries of the fields, which would take the form of irregular circles or fans, like those that occur in some localities.

An excellent example of the results that naturally would follow from a desultory occupation was observed in the Urubamba Valley, near Calca, in a district where crops can be grown without irrigation. The contrasting conditions are represented by the district around Ollantaytambo, where evidences of regular planning are encountered on every hand. The regular planning of the ancient Peruvian cities has been remarked by Wiener, who gives the plan of Ollantaytambo as an example; but the regularity in the laying out of the lands and irrigation works affords still better evidence that the plan was made before the district was occupied. A town site might be changed or reorganized by a powerful chief, but it would be more difficult to believe that all of the agricultural lands would have been readjusted if they had been occupied at first in a desultory manner. In the Peruvian system the agricultural structures are more permanent than the dwellings.

In relation to agriculture the results of archeological research in the two hemispheres present a striking contrast. In the Eastern Hemisphere the general result is to show that the civilizations supposed to be the most ancient are not really primitive or aboriginal. They did not have their beginnings and early development in Egypt or Mesopotamia, but were brought from elsewhere. The early dynastic Egyptians came into the Nile Valley from the East and the early Babylonians into the valley of the Euphrates from the South. Nor does it appear that either of these alluvial valleys afforded natural conditions that were really favorable to the practice of agriculture by a very primitive people, nor types of plants suited to domestication.

**A MOST INTERESTING COMPARISON**

The crop plants as well as the ancient agriculturists came into the valleys as a result of colonization. In other words, the valleys were developed as reclamation projects by peoples already skilled in agricultural arts and with an established social organization.

Where these civilized colonists came from is still a question. They are supposed to have come into Egypt and Mesopotamia from southern Arabia and to have been a maritime people, as well as agricultural; but they have not been traced back to their original home or to the place where their agriculture and other arts were developed.

The study of agriculture in America has led to directly opposite results. The older idea that the primitive civilizations of Mexico and Peru were originated by colonists from China, the Malay region, or the East Indies has gradually given way to a belief among archeologists and ethnologists that the primitive civilizations of America were developed entirely on the American continent. Certainly this appears to be true of the art of agriculture. All of the economic plants on which the ancient American agriculture was based are now believed to be of American origin, and a very large proportion of them appear to have come from South America, and especially from the region of Peru.

Of course, it would not follow that agriculture might not have originated in other places as well as in Peru. All that...
ANCIENT AQUEDUCT AND TERRACES

A portion of the long walls crossing the Urubamba Valley at Ollantaytambo, shown in the general view on page 302.

Whatever the motive or the pressure that led to the development of agriculture under such conditions, of the fact there can be no doubt. That the system of agriculture did develop here is proved by the fact that the plants on which the agriculture was based were indigenous, and that no such system existed in other parts of America.

YOU CAN LOOK FROM THE EQUATOR TO THE POLES

Agriculture in Peru is a matter of altitude. Geographically you are in the tropics, but agriculturally you may be anywhere between the Equator and the northern limit of agriculture, at the Arctic Circle. Moreover, you can find this.
A TERRACED VALLEY ABOVE OLLANTAYTAMBO

The terracing of this narrow valley is amazing. Parts of it are shown in several photographs that follow (pages 506 to 518). The high slopes at the left were also cultivated in former times. At the base of the steep mountain on the right is a large slide of loose stones, several hundred feet high. All this flat valley is artificial—that is, it was a gully—and would so have remained if the Peruvians had not broadened it and leveled it out (see text, page 496).

range of conditions, not by going to different parts of the country, but in different parts of the same valley, in places within plain sight of each other. Thus from among the plantations of sugar, coca, or cacao, at Santa Ana one can see at the other end of the valley some of the peaks of the Cordillera, covered with glaciers and perpetual snow. It is like looking from Jamaica to Alaska. Even on foot or on mule-back only a few hours are required to climb up or to descend through the full range of agricultural possibilities.

No very definite division into agricultural belts is possible. Some crops are confined to the high altitudes and others to the low, but there is endless overlapping with the intermediate crops. Three agricultural belts can be distinguished on the basis of the principal food plants. The cultivation of cassava, called yuca in Spanish and rumu in Quichua, may be allowed to characterize the lowest or tropical belt, which extends in the Urubamba Valley to an altitude of about 6,000 feet. From this altitude to about 11,000 feet is the intermediate belt, with maize as the principal native crop, while in the Andine belt, above 11,000 feet, the potato is the most important food plant.

In some districts wheat is grown rather extensively and is often the chief crop at altitudes between 10,000 and 12,000 feet. Barley and broad beans (habas) are two other European crops that are planted on a relatively large scale at high elevations. Above 12,000 feet the people are engaged chiefly with the grazing of herds of llamas, alpacas, cattle, and sheep; but potatoes and other Andine crops are planted on a small scale for the support of the pastoral population. In most places agriculture does not go much above 13,000 feet, but on some of the slopes above the Pass of La Raya potatoes are planted at altitudes above 14,000 feet. The vines make normal development and produce abundantly when planted in good soil.

Even among people of intelligence and interest in agricultural problems the superficial fact that Peru lies within the tropical zone is commonly allowed to obscure the relation of its agriculture to that of temperate regions. The fact is, of course, that in spite of the proximity
A RECLAMATION PROJECT MADE IN PERU WHEN THE EUROPEANS PROBABLY LIVED IN CAVES

Immediately below Ollantaytambo are these broad terraces, covering more than a square mile. The soil in these terraces was assembled and put in place as carefully as for the terraces shown on page 497 (see text, page 496). The land produces a crop every year and probably has done so for centuries. In the background along the slope at the left may be seen an inclined road, where the ancient people dragged up the enormous stones to the top of the ridge above the hanging gardens shown in previous photographs.
to the Equator large areas of the plateau regions of Peru have not merely temperate climates, but conditions that could be more correctly described as cold temperate, subarctic, or alpine.

THE LESSON OF THE POTATO

In spite of having come from intertropical South America, the potato does not endure heat, but thrives at the extreme limit of agriculture in the Northern Hemisphere—Norway, Finland, Siberia, Alaska, and Newfoundland. Likewise in the Southern Hemisphere the potato was carried, even in pre-Spanish times, to the cold coast belt of Peru and Chili, and has since been taken to South Africa, Tasmania, and New Zealand (see also pages 510 and 513).

The wide utilization of the potato has proved strikingly that a plant able to grow on the high plateau of Peru may be adapted to any of the coldest regions where agriculture is practiced in other parts of the globe, and indicates that the other domesticated plants of Peru may also be useful to all the temperate and subarctic regions of the world.

MORE PLANTS WERE DOMESTICATED IN PERU THAN IN ANY OTHER PART OF THE WORLD

It was fortunate for the rest of the world that the ancient Peruvians practiced agriculture under so wide a range of natural conditions, since this led to the domestication of a large series of crop plants. More plants appear to have been domesticated in the Peruvian region than in any other part of America. A large proportion of the cultivated species were limited to this part of the world, so that no question can be raised of their having been brought from other regions. Other kinds of crop plants used by the ancient Peruvians were widely distributed in ancient America, more especially the tropical species, those that are grown at low elevations. If these also originated in Peru, that region was responsible for by far the larger part of the American series of crop plants, more than all other parts of America taken together.

Among the more important crop plants that were cultivated by the ancient Peruvians were maize, or Indian corn, potato, sweet potato, and cassava. The following partial list of the Peruvian crop plants may give an idea of the extent and variety of domestications that were accomplished in Peru:

- Achupalla (pineapple), aïn (Tropaeolum), apichu (sweet potato), apinecoya (grandadilla), arracacha (Arracaca), chirimoya, chui (bean), coca (Erythroxyllum), cumara (sweet potato), inchis (peanut), oca (Oxalis), pallar (Lima bean), papá (potato), papaya, poro (bottle-gourd), purutu (frejol), quinoa (Chenopodium), racoto (Capsicum), runu (Manihot), sahuinto (guava), sara (maize), tintin (Tacsonia), tomate (Lyco persicum and Cyphomandra), tumbo (Tacsonia), ullucu (Ullucus), uncucha (Xanthosoma), utcu (cotton).

VARIETIES OF PERUVIAN CORN

A complete list of the plants that were cultivated by the ancient Peruvians has yet to be made, but it will probably include between 70 and 80 species. A large part are root crops, vegetables, and fruits, but some are seed crops, pot herbs, condiments, medicinal plants, dyes, and ornamentals. Annual plants predominate in numbers and importance, but perennials, shrubs, and trees are also well represented.

Maize, or Indian corn, is a remarkable plant, botanically as well as agriculturally. It is entirely unlike any other crop and has very few relatives in the plant world. The early explorers found corn in general cultivation in all of the agricultural areas of North and South America, but no wild form has been discovered. Where maize originated is still a question. Some writers have favored Mexico and others Peru. The relative importance of maize was greater, no doubt, in Mexico, where not so many other plants were cultivated as in Peru. Another reason for associating maize with Mexico is the occurrence of the grass called teosinte, which crosses readily with maize and was formerly believed to represent the ancestral form.

That the cultivation of corn goes very far back in Peru is indicated not only by the abundance of specimens found in the
ancient graves, but by the fact that the type of maize that furnishes the bulk of the Peruvian crop is peculiar to that region. The question is not merely of varieties, which are very numerous in both continents, but of a whole series of varieties very unlike any that are known from Central America or Mexico.

This Peruvian maize, or Cuzco corn, as it has been called in the United States, is characterized by the very large kernels, some of them nearly an inch broad, almost the size of chestnuts. The large kernels are an advantage from the standpoint of the natives of Peru, who are accustomed to eating corn a kernel at a time. The usual method of cooking corn, and everything else in Peru, is by boiling, the reason being probably that more fuel would be required for roasting or parching. Fuel is very scarce and expensive in all of the populous districts of Peru.

PERUVIAN CORN MAY HELP US

In the United States the large kernels would be of less importance, but the Peruvian type of maize may prove interesting in another way. The fact that the Cuzco corn is the only type grown extensively on the high slopes and tablelands may mean that it is more suited to cool climates than other sorts of maize.

The large kernels have attracted the attention of travelers, and numerous attempts have been made to introduce the Cuzco corn into the United States. Bayard Taylor raised a few plants in Pennsylvania as far back as 1865 from seeds brought home by Squier, the well-known writer on Peru.* Such experiments with the Cuzco corn in the United States have given a completely misleading impression regarding the habits of the plant.

The usual behavior of the Cuzco corn in the United States is to produce plants of enormous size that mature very little seed, often none at all. It has been taken for granted that the size of the plants should be in proportion to the enormous kernels, and that our seasons were not long enough to permit this type of corn to mature.

But in Peru one does not see these gigantic, infertile plants, nor any indication that the corn crop requires a large amount of heat to bring it to maturity. The impression one gets from the Peruvian corn-fields is that the plants are not taller than with us and rather more slender, the most striking peculiarity being the prevailing red color of the foliage. The best development and largest ears of the Cuzco corn are found in some of the higher valleys, at elevations between 9,000 and 11,000 feet, in districts where the summer climate is cooler than in any of the corn-growing regions of the United States.

Thus it becomes apparent that the possibility of utilizing the Cuzco type of corn in the United States is still practically un-

*American Agriculturist, 40:9, January, 1881.
ANOTHER ILLUSTRATION TO SHOW THAT THE SOIL AND SUBSOIL OF THE TERRACES WERE PLACED AS LABORIOUSLY AND CAREFULLY AS THE WALL ITSELF

The structure of a large agricultural terrace exposed along the stream near the middle of the valley, seen in the photograph on page 506, shows that these broad terraces are as truly artificial as the narrow ones on the slopes. A part of the old retaining wall that protected the terrace from the stream is still in place at the right, while the naked bank at the left has the same arrangement of fine soil above and loose stones for subsoil as the narrow terraces of the hanging gardens (see text, page 496).

tried, because of our lack of information regarding the normal behavior of the plant and the natural conditions to which it is adapted. As might have been expected, if these facts had been known, the best results thus far obtained from the Cuzco corn in the United States have been in California, in the cool climate of the coast districts, where there is too little heat for our eastern varieties to thrive.

Thus the first step in determining the possibilities of acclimatizing and adapting South American varieties of corn to use in the United States is to place them under conditions where the plants can behave in a normal manner and mature seed. In experiments conducted last year near the coast of southern California all of the varieties from Peru and other table-land regions of tropical America were able to mature seeds, which many of them had failed to do when planted in the Eastern and Southern States.

A CORN THAT GROWS AT AN ELEVATION OF 13,000 FEET

The cultivation of corn in a cool climate has been pushed to an extreme limit on the high plateaus around Lake Titicaca, where a dwarf form of corn is planted at an elevation of nearly 13,000 feet. The specialized nature of this variety became apparent in the experiments near San Diego, where it matured in less time than any other, or in about 60 days. Worthless as it would appear from the insignificant mounds that we purchased from the Indian women in the market of Copacabana (page 523), this dwarf table-land form is distinctly of interest as an example of a variety with much lower heat requirements than those we now
have, which shows a possibility of extending the range of the corn crop in the United States.

In the tropical portions of the lower valleys of the eastern Andes the Cuzco type of maize gives place to another with larger ears and smaller kernels, much more similar to the Mexican and Central American varieties, or to those that are cultivated in the United States. If maize originated in the Peruvian region, it would be easy to understand that the varieties grown at the lower elevations would be much more likely to spread to North America than the varieties that are confined to the cool table-lands.

The existence of the specialized high altitude types of maize in Peru may be taken to indicate either a very long period of adaptation to the high altitudes or a possible origin of maize as a high-altitude plant. Whether the course of adaptation has been upward or downward, the success of the process is very significant of the possibilities of much wider utilization of maize in cool regions than has been considered possible in the past.

Maize is not a staple crop at very high altitudes. Above 12,000 feet it is raised in only a few places, not as a regular food, but rather as a luxury for making the native beer, or chicha. To take the place of maize, the natives of the elevated districts use plants that are closely related to one of our common weeds, called “pigweed” or “lamb’s-quarters.”

**PIGWEEDS FOR OATMEAL**

Two species of pigweeds are regularly grown in the valleys that lead up to the Pass of La Raya, between Cuzco and Lake Titicaca. The large species, which often attains a height of 3 or 4 feet, is called *quinoa*, while the small species, seldom more than a foot high and often only 5 or 6 inches, is called *cañihua*. In general appearance both species are much like our pigweed, but they are regularly planted and harvested by the Peruvians, and are in fact the only seed crops grown in the elevated districts that are too cold for maize.

Considering *quinoa* as a high-altitude substitute for maize means that it is valued chiefly for making beer, and in some districts most of the crop is used in this way. Only the white-seeded variety of *quinoa* is considered suitable for eating, the others being very bitter, so that they have to be boiled, with several changes of water, in order to be made palatable. The white *quinoa* makes an excellent breakfast food, fairly comparable with oatmeal, and likely to be preferred by many, both for the taste and texture. The seeds become soft with cooking, but retain their form, and do not appear so slimy as oatmeal when treated in a similar manner. The leaves of *quinoa* are also cooked and eaten as a pot-herb.

The other pigweed crop, *cañihua*, is raised altogether for food. The seeds are much smaller than those of *quinoa* and of a grayish color in the mass. They are parched slightly and ground into a fine flour. The chief use of *cañihua* is as a travel ration for the shepherds who go out on the high plateaus with their flocks of llamas, alpacas, and sheep.

**THE TREASURE OF THE INCAS**

The gold of the Indies was the attraction that led Columbus to sail westward, that carried Cortez to Mexico and Pizarro to Peru. The Incas had large stores of the precious metal, representing, no doubt, the accumulations of many centuries. The capture of such a booty resounded through Europe. Spain became for a time the wealthiest, as well as the most powerful, nation of Europe, and this was ascribed to the gold of Peru.

But Peru held another treasure much more valuable for the nations of Europe than the golden booty of Pizarro. Carrying the potato to Europe was an event of much more profound significance in relation to the subsequent history of the world than sending the Inca gold to the coffers of Spain. But nobody understood the value of the potato, and its Peruvian origin was generally forgotten before the plant became well known. Instead of Peruvian potatoes, we call them Irish potatoes.

The potato was the basis of the ancient Peruvian nation and has attained almost the same importance in other parts of the world within the last hundred years.
TERRACES REACHING ALMOST TO THE SNOW

Not only the terraces, but all of the higher slopes, appear to have raised crops in ancient times, and cultivation continues in a few places that can be distinguished near the top of the ridge. The broken slope near the middle of the photograph is on the side of a deep ravine filled with a dense forest, which is spreading gradually over the neighboring slopes (see page 500).
The Urubamba River Opposite Ollantaytambo

An ancient retaining wall still protects a bank of terraces along the base of the steep southern slope of the valley. The terraces are overgrown with tara trees (Caesalpinia pectinata), pinco pinco (Ephedra), chuchao (Fouquieria), and several species of cacti.
The instinctive prejudice against new food plants prevented any general utilization of the potato in Europe for over two centuries, and it did not begin to be grown as a crop until the period of the French Revolution. Even then it had to be forced on the public by the persistent efforts of the French philanthropist, Parmentier, who demonstrated its food possibilities by establishing a large number of soup kitchens for the poor of Paris. Potato soup still bears the name Parmentier—a homely memorial, but one that might not be ungrateful to a philanthropist.

Historically speaking, the general utilization of the potato is still relatively recent. Less than a century ago it was still considered as something of a novelty among the farmers of the United States. Thus, in 1856, we find in the American Agriculturist the following statement:

"I have worked a farm over fifty years, and have cultivated potatoes more or less every year. Fifty years ago little was thought of this root. A row or two were planted on the outside of corn-fields, or in some corner of a lot unfit for anything else. Ten to fifteen bushels was an ample supply for a family. There is a great difference between then and now with respect to this crop, for potatoes are now one of the most important branches of agriculture" (Vol. 15, p. 256).

Contrast with this statement the facts that about 400,000,000 bushels of potatoes are produced annually in the United States. The world’s crop of potatoes must be more than 6,000,000,000 bushels. The statistics of production for 1912 showed 5,931,493,000 bushels, but included no returns for the ancient centers of production in the table-land regions of Peru, Bolivia, Ecuador, Colombia, and Venezuela, nor for Central America or Mexico. As the potato-growing districts are the chief centers of population in all these countries, many millions of bushels must be produced by them.

The world total of six billion bushels probably much exceeds that of all the gold that the conquerors took from the Incas.

**THE HOME OF THE POTATO CAN GIVE US OTHER VALUABLE FOODS**

As the home of the potato, Peru may be looked upon as the source or fountain head from which must come new stocks to strengthen and maintain the varieties of this great food staple. Just as continued importation of live-stock breeds is necessary to renew our American strains, it is now beginning to be urged that new and vigorous varieties of potatoes be found to offset the gradually waning virility of old and run-out stocks.

Other possibilities lie in the direction of securing varieties that are really superior to any that we now have. Notwithstanding the enormous importance that has been attained by the potato in the agriculture of Europe and the United States, no adequate attempt has been made to secure the best forms for our use.

Peru has many kinds of potatoes superior in quality to those that we cultivate, but most of them would not be considered promising with us, because the tubers would be hard to peel on account of irregular form and very deep eyes. Breeders of potato varieties have been influenced very largely by the size and form of the tubers, with quality and flavor left largely out of account. But, with such an infinity of forms to draw upon in South America, it should be possible to combine all of the desirable features. Some of the Peruvian varieties are almost ideal in form (page 524).

It seems very strange, in view of the importance attained by the potato, that there should not have been a more general appreciation of this and the other plant treasures that South America has bestowed upon the other continents. Not only the Peruvian varieties of potatoes, but many of the agricultural plants of Peru, are still entirely unknown in other countries. Much less has there been any systematic effort to gain what might be described as an agricultural cognizance of these treasures—that is, a practical knowledge of the nature, habits, and uses
FARMING AT AN ANGLE OF 45 DEGREES

A slope in the valley of Ollantaytambo, with an angle of about 45 degrees, or steeper than the roofs of most houses, is covered with transverse ridges, showing that the entire surface was cultivated in former times. Parts of the same slope farther to the left are still cultivated. The structures in the foreground are ancient graves or storehouses, perched on a large rock, seen from a ruined town called Pumamarca.
of the plants. Of some of them even botanical information is lacking. Indeed, it may be said that knowledge of some of these plants has actually declined since the time of the conquest.

The account of Peruvian economic plants written by Padre Cobo less than 70 years after the conquest is still the most extensive and detailed work on the subject.

OTHER PERUVIAN ROOT CROPS

The agriculture of Peru is based on root crops, primarily. Seed crops are relatively few, and, with the exception of corn, are almost incidental to the numerous root crops. Even corn is used largely for making chicha rather than for food, especially in many districts at higher elevations, where potatoes are the chief article of diet.

In order to understand the domestication of many root crops in Peru, it is necessary to go back to a pre-agricultural or an extremely primitive agricultural state, when people subsisted entirely or very largely upon wild roots, and resorted every year to the gathering of these, instead of being able to rely entirely upon the products of cultivated land, as in a more advanced state of agricultural development. With agriculture developed to the point of complete independence of the wild-food materials, no more domestications of food plants are likely to be made, as none seem to have been made during the entire historical period of civilized European agriculture.

From eating a great number of plants, as the wandering savages do, agricultural man gradually becomes restricted by habit to the foods that are produced by cultivation, and he finally reaches a stage where the idea of going out and bringing in a wild plant to cultivate as food is entirely foreign to the mind. To the present-day Indians of Peru the cultivated food plants represent a perfectly distinct and definite class. The plants that are sown are sown, and the plants that are wild are wild. They accept as a matter of course that there are wild potatoes, wild ocas, wild anís, wild arracachas, wild achiras, and so on down the list; but it is not supposed that these have any-thing to do with the cultivated forms of the same types, or that anybody would be foolish enough to plant the wild kinds and expect to raise crops from them.

If any more plants are domesticated in Peru, the Indians are not likely to do it—that is, for their own use. If some new crop should be introduced by the white people, or if a demand should arise for the product of a wild plant that could be cultivated easily, the Indians might go to planting it, for their agricultural habits and instincts are highly developed; but either of these contingencies is very different from a spontaneous domestication of a new native food plant on their own initiative and for their own use.

In the alpine or Andine belt, where the potato is the chief crop, three other root crops are generally grown, by the same methods and often in the same rows with the potatoes. These Andine root crops are the oca (Oxalis tuberosa), the aní (Tropaeolum tuberosum, page 526), and the ullucu (Ullucus tuberosus). The tubers of all of these plants are remarkably alike and similar to some of the varieties of potatoes, although the plants have no relation to potatoes or to each other. The oca is a relative of our sheep sorrel, the aní of the common flowering nasturtium, and the ullucu of the Madeira vine. Though not attaining the size of large potatoes, the other tubers are more attractive in appearance and seem to have even better keeping qualities.

The possibility of utilizing them in the cooler parts of the United States is worthy of careful consideration. Their value might lie, as in Peru, in supplementing the potato, and thus affording a more varied vegetable diet. They yield well and are easily grown. Though natives of a tropical country, these crops are found only in the cool elevated districts and are, like the potato, intolerant of high temperatures.

In the lower part of the potato belt there is another root crop—the yacon or llacón (Polymnia sonchifolia)—comparable to the so-called "Jerusalem" artichoke, which is supposed to be a native of Mexico. It produces large, compact clusters of thick, fleshy roots tapering at both ends and with a strong external re-
semblance to sweet potatoes. The flesh is crisp, juicy, and has a pleasant, sweetish flavor, rather better than that of the Jerusalem artichoke. The yacon and ajipa (Cacara) are eaten raw, while all other root crops are cooked.

At elevations below 6,000 feet another series of root crops is grown, consisting of numerous varieties of rumu (Manihot), uncucha (Xanthosoma), apichu and cumara (two types of sweet potatoes), achira (Canna), and unguna (Curcuma).

THE HARVESTING, STORAGE, AND DISPOSITION OF THE CROPS WERE DIRECTED BY THE GOVERNMENT

According to the early Spanish historians, the Incas had complete control of the land and of all of the agricultural activities of the people, from the planting of the seed to the harvesting, storage, and disposition of the crops. An extensive system of public storehouses was maintained, not only at the chief centers of population, but along all of the principal routes of travel and in the high passes between the valleys.

A complete system of accounts was kept by means of quipus, or knotted cords, with different kinds and colors of knots to represent different quantities and classes of objects. The system of public accounting was used not only to determine the taxes or contributions to the government, but as a practical form of insurance, a failure or deficiency of crops in one section being made good from other parts of the country, where more abundant harvests had been secured. When the country was devastated at the time of the Spanish conquest the same system of making good the local losses was employed, “in order that all might not be devastated,” as we learn from the account of Cieza de Leon,* written probably about 1550:

“So it was arranged, and as soon as the Spaniards were gone the chiefs assembled, the quipus were examined and checked, and if one province had lost more than another, that which had suffered less made up the difference; so that the burden was shared equally by all. To this day these accounts are kept in each valley, and there are always as many accountants as there are lords, and every four months the accounts are made up and balanced.”

In like manner it is apparent from the accounts of the early historians that the recognized object of the religious system was to secure favorable conditions for the growth of the crops. Like many other primitive peoples, the Incas had a system of sacrifices or offerings to secure the favor of the gods. Though not a cruel or bloodthirsty people like the Aztecs, whose sanguinary deities required a continual butchery of captives, there is no longer any doubt that the Incas also had a system of human sacrifices to secure the favor of the deity for the Inca and his people. A special religious caste of vestals or Virgins of the Sun was maintained at some of the chief religious centers, and numerous burials of strangulated women have been reported by Uhle at the great temple of Pachacamac, near the coast south of Lima. The object of these sacrifices, as stated in a passage quoted by Uhle from Molina, was “that the Creator might grant the Inca victory, health, and peace.”

How thoroughly ingrained and instinctive the Inca system was may be best understood from the extent to which it still persists, nearly four centuries after the conquest. The need of “paying the Incas,” in order to be assured of good crops and natural increase of the flocks, is still felt by thousands of the rural Indians and manifested in many ways. In the native markets of all of the larger towns there is an extensive trade in medicinal and aromatic plants, the chief use of which is for burnt offerings to the Incas to avoid the risk of offending them and thus inviting injury or loss.

Other curious survivals of the ancient system are seen in the little images of metal, clay, or stone which are buried in the ground for the benefit of the crops. At Cuzco minute images are made of metal, but at La Paz the same purpose is served by carved stones, called mullo.

THE COURSE OF AN ANCIENT AQUEDUCT

The indistinct dark line that crosses the high slope, shown about two inches below the top of the photograph, represents the course of an ancient aqueduct carried for many miles along a mountain wall hundreds of feet above the valley. In the foreground, near the ruined town of Pumamarca, is a group of Inca storehouses. The stream in the bottom of the valley is carried in a straight course along the farther side of the valley bottom. Note canals cutting across mountains (see text, page 398).
ARTIFICIAL LANDS ALONG THE URUBAMBA RIVER BELOW PISAC

For about a mile the river has been confined by walls to a straight channel and the land leveled to the base of the slope where narrower terraces were built, the first two with broad, sweeping curves (see page 407).
or piedras de Charasani. These are still used and sold regularly in the native markets by the dealers in medicines and aromatic drugs. These curious sculptures take the form of small models of fields and farmsteads, with rows of sheep and cattle. They remind one of the colonnades of bulls in Egypt, which may have been constructed for the benefit of the animal industry of the Empire of the Pharaohs.

DESTRUCTION OF THE INCA SYSTEM

Agriculture was a fundamentally important step in the development of civilization, because it constituted the discovery of a way to live and let others live, too. As long as primitive man remained dependent upon game or natural products there was seldom enough to go around. The natural attitude of non-agricultural tribes roaming about in search of food is to fight all strangers on sight, and this attitude persists in many nations that have adopted agriculture as an art, but are not yet converted to it as an ideal or philosophy of existence.

Dominance of the predatory instinct is seen when people would rather raid the harvests of others than raise crops of their own. How thoroughly agricultural were the ancient Peruvians in habits and instincts is evidenced by their greater freedom from the predatory instincts in comparison with our European race. In this respect the Incas were admittedly superior. Several of the early historians give testimony to this aspect of the Inca civilization. Cieza de Leon and other thoughtful men among the conquerors saw very clearly that something had been destroyed that could not be replaced.

The most convincing testimony was given by one of the soldiers who came with Pizarro, the last survivor, he tells us, of the original band, who had the best opportunity of knowing what the Inca organization was before the conquest; and after all of his companions were gone, the idea of regret and remorse for the destruction that had been wrought grew in the mind of this aged warrior. He cast about for a way to discharge his conscience by telling the King of Spain the truth about the Inca civilization. He knew that the king's ear had been sought by many adventurers, who carried tales of wrongs to the Indians as a means of securing their own advantage, and that others had countered with tales of barbarous practices among the Indians, some of them fabricated and others carried over from the savage tribes of other parts of America. Also the truth was bitter, and the king might not hear it willingly; certainly nobody who hoped for...
CUZCO, THE LARGE-KERNEL CORN OF PERU

In the middle farming zone of Peru, at elevations between 8,000 and 11,000 feet, the Cuzco type of corn is the principal crop. It is characterized by very large kernels, sometimes nearly an inch broad. Cuzco is native to the cool tablelands of Peru rather than the tropical valleys. This fact throws new light on its behavior in the United States. In the hot summer climate of the eastern States it usually fails to set seed, but it may be of use on the Pacific coast or other parts of the United States where there is too little heat for our varieties to mature (natural size).
THE LARGE CUZCO KERNELS ARE EATEN ONE BY ONE

The huge size of the Cuzco kernels (shown on the left) is more apparent when compared with the kernels of Boone County white, one of our popular varieties (shown on the right). The large kernels are eaten one at a time in Peru, like grapes or chestnuts. The meat slips out of the skin when the boiled kernel is pressed between the thumb and finger. Ripe corn is eaten this way, as well as green corn, and is a staple article of diet among the Indians, who call it moti (natural size).

for royal favor would undertake to deliver such a message.

AN IRREPARABLE LOSS

The problem was not easy; but the aged warrior had a resourceful mind as well as an active conscience, and he found a way to give his testimony a lasting record. Instead of setting out on a vain journey to the court of Spain, he waited quietly at Cuzco and let death deliver his message to the king. As the last of the conquistadores, he claimed the right to send the king a legacy of truth regarding the Incas:

"True confession and protestation in the hour of death by one of the first Spaniards, conquerors of Peru, named Marcio Serra de Lejesama, with his will proved in the city of Cuzco on the 15th of November, 1589, before Geronimo Sanchez de Quesada, public notary.

"First, before beginning my will, I declare that I have desired much to give notice to his Catholic Majesty King Philip, our lord, seeing how good a Catholic and Christian he is, and how zealous in the service of the Lord our God, concerning that which I would relieve my mind of, by reason of having taken part in the discovery and conquest of these countries, which we took from the Lords Yncas, and placed under the royal crown, a fact which is known to his Catholic Majesty.

"The said Yncas governed in such a way that in all the land neither a thief, nor a vicious man, nor a bad, dishonest woman was known. The men all had honest and profitable employment. The woods, and mines, and all kinds of property were so divided that each man knew what belonged to him, and there were no lawsuits. The Yncas were feared, obeyed, and respected by their subjects, as a race very capable of governing; but we took away their land, and placed it under the crown of Spain, and made them subjects.

"Your Majesty must understand that my reason for making this statement is to relieve my conscience, for we have destroyed this people by our bad examples. Crimes were once so little known among them that an Indian with one hundred thousand pieces of gold and silver in his house, left it open, only placing a little stick across the door, as the sign that the master was out, and nobody went in. But when they saw that we placed locks and keys on our doors, they understood that it was from fear of thieves, and when they saw that we had thieves amongst us, they despised us. All this I tell your Majesty, to discharge my conscience of a weight, that I may no longer be a party to these things. And I pray God to pardon me, for I am the last to die of all the discoverers and conquerors, as it is notorious
AGRICULTURE IS STILL PRACTICED INTENSIVELY HERE

These terraces, of rather irregular form, are in a thickly inhabited district about the temple of Viracocha, near Tinta, in the Vilcanota Valley, at an altitude of about 11,000 feet.
The culture of maize is carried to its extreme limit in a few places on the islands and slopes around Lake Titicaca, at an elevation of nearly 13,000 feet. The diminutive ears were bought in the market at Copacabana, on the south shore of the lake, where a great fair is held annually, near the end of the winter season, in August. In a planting of this type of corn on our Pacific coast, near San Diego, last year ears about twice as large were matured in sixty days, indicating that the Copacabana corn may be of use in breeding varieties for short-season conditions in the United States.

that there are none left but me, in this land or out of it, and therefore I now do what I can to relieve my conscience."*

The message carried its own verification. In testifying to the virtues of another race, Serra showed himself possessed of the highest virtues of his own,

SIXTEEN POTATO VARIETIES FROM ONE FIELD

The pile is a mixture of many varieties grown at a high elevation near the Pass of Panticalla. The natives do not grow fields of separate varieties, although they distinguish and have names for many different sorts, which are widely recognized.

THE POTATO, PERU'S GIFT TO MANKIND, HAS ENRICHED THE WORLD MORE THAN THE IMMENSE HOARDS OF GOLD TAKEN BY THE SPANIARDS

(SEE TEXT, PAGES 510-515)

The popularity of a potato in our market depends largely on whether it is easy to handle and peel. It would be hard to imagine a more convenient potato than this Peruvian variety, called Pucaywilla, of regular, oblong, flattened form, even surface, and few, shallow eyes. It was found by Professor Bingham between Pucayura and Arma, at an altitude of about 12,000 feet (slightly reduced).
A variety of potato grown at the upper limit of cultivation, on the high slopes near the Pass of La Raya, at an elevation of over 14,000 feet. The neighboring vines had their leaves killed by the frost, but this plant was entirely uninjured. Both the rootstocks and the tubers are bluish purple. The variety called Tutu is said not to be edible in the fresh state, and to be used only for the making of churros by freezing and drying (natural size).
IN ADDITION TO THE POTATO, PERU HAS ORIGINATED MANY VALUABLE ROOTS (SEE PAGES 513-515)

These are not specimens of hand-decorated Japanese art, but were striped by nature before the tubers were dug. Why the subterranean part of a plant should be decorated with purple stripes is hard to imagine, but the case may be interesting to those who believe that colors must be useful. Two varieties are shown, both called Checcheña, at Ollantaytambo. The variety at the right, with the larger and more irregular tubers, also has the stripes fewer, shorter, and of a deeper purple color (natural size).
COCA-DRYING YARD AT SANTA ANA

The leaves are spread out on the stone pavement and dry rapidly in sunny weather. Rainy weather interferes seriously with the drying operation, for the leaves may have to be spread out and carried in several times. If a sudden rain wets the coca before it can be taken under cover, the leaves are discolored and their commercial value is reduced.

ing their accounts to convey a special impression, but no literary bias can be suspected in Serra. He tells us only a few facts, but in a way that proves his competence to speak. His testimony is not in conflict with the best historians, but more vital and convincing.

If Serra had charged the destruction of the native civilization to Pizarro or to any of those afterward in authority in Peru, it would be possible to suppose that his view of the Inca organization was colored by revenge or lasting resentment against some of his own people; but of this there is no indication. He includes himself with the others, blames nobody, and suggests no remedies. Telling the truth to the king is all that he undertakes; but in doing that he lifts the curtain of the past and lets us see for one moment through his eyes, not the mountains or the monuments or the crops of Peru, but the living Inca people and their relations to each other, the most essential condition of the development of the ancient civilization.

THE INCAS HAD THE MOST COMPLETE SOCIAL ORGANIZATION OF WHICH WE HAVE RECORD

We see that the Inca agricultural system was not only the most complete form of social organization of which we have any record, but also gave the most adequate adjustment of the human relations that lead to continual conflict and confusion in other forms of society.

This is not saying that the Inca system was the best possible, or that it was calculated to lead to the highest development of humanity, or that we should adopt it; but the system is interesting and worthy of being understood, since social organization undoubtedly was a very important factor in enabling the Incas and their predecessors to accomplish what they did in agriculture and the attendant arts.

Certainly no unorganized people could have executed the ancient reclamation projects or established themselves under so wide a range of natural conditions or domesticated such a varied series of crop-plants. In domesticating these plants
WHERE FARMING IS UPHILL WORK

This coca plantation is on a very steep hillside near Colpani, in the lower Urubamba Valley, at an elevation of about 5,000 feet. Many plantations are made in this way on steep slopes. Contrary to the custom that prevails in most tropical countries, the rows always run up and down the slope instead of across.
LEAVES, FLOWERS, AND MATURE BERRIES OF THE COCA PLANT

All the parts are shown in natural size. The leaves, which are the source of the cocaine drug, are very peculiar. The two surfaces are quite unlike—the upper, deep green, smooth, and velvety; the lower, light green, with a band of paler color on each side of the midrib, inclosed by fine ridges. The young leaves are rolled in from the margins, so that only this median band of the lower surface is exposed at first.
A LARGE COCA PLANTATION AT SANTA ANA

The crop of leaves has just been harvested, leaving the bushes stripped. As soon as the leaves are gathered, the plantation is irrigated and another crop of leaves begins to grow, and matures in about three months. With four crops in a year a good coca plantation is very profitable for the owner and government (see page 473), but a cause of much misery and degradation to the people. Santa Ana is a famous place, having been the chief center of missionary activity in the eastern valleys of the Andes in the early colonial period. The buildings were constructed by the Jesuit fathers.
A NATIVE PERUVIAN COTTON

Leaf, flower, and boll of the native cotton grown in the eastern valleys of the Andes. This species (Gossypium barbadense) is entirely different from any grown in the United States. The plant is somewhat like the Sea Island cotton, but the bolls are much larger than those of Sea Island and the fiber is more like Upland cotton (natural size).
THE TREE TOMATO, CYPHOMANDRA

It is a relative of the true tomato, but is more upright, with a single strong stalk and horizontal branches at the top, forming a small tree five or six feet high. The fruits are narrowed at both ends, yellowish red in color, firmer in texture than our tomatoes and with a somewhat stronger taste. The plant endures more cold than the true tomato and is cultivated at elevations of 6,000 to 10,000 feet, whereas the true tomato is raised only in the warm valleys, below 6,000 feet (natural size).
Wild tomatoes of the cherry type are very abundant in the lower Urubamba Valley about Santa Ana at an elevation of approximately 3,000 feet. The color of the fruits is deep red and the taste very agreeable. The tomatoes cultivated by the Indians are of the same type and the fruits not much larger (natural size).
A WILD TOMATO OF THE EASTERN ANDES

Growing as a large woody vine at elevations of 8,000 feet, this plant trails over bushes 10 to 12 feet high. The fruits are of uniform size and of the usual form of our cultivated tomatoes. The flesh under the skin is thick and firm, so that the fruits can be handled easily and kept for long periods. There is a possibility of making use of it in hybridizing and breeding new varieties. If such a cross can be made, it may be expected to give a wide range of variation and yield new types of fruit adapted to special purposes, such as woody perennial varieties that can be trained over arbors like grape-vines, or varieties with special flavors, greater firmness of flesh, and improved keeping qualities (natural size).

the ancient Peruvians performed a lasting service for the whole world. We are all beneficiaries of the ancient Peruvian agriculture.

From our point of view, the steep, narrow, rocky valleys of southern Peru would represent a most unfavorable condition for agricultural development; but no doubt the ancient people saw things in a different light, and what they were able to accomplish is a lesson in possibilities that our own race has still to learn. We are beginning to see that the agricultural ideal of human welfare, of living and letting others live around us, is higher than the military or savage ideal of killing all strangers through fear or jealousy of competition. But our traditions, literature, and social institutions are still so largely military or commercial that we have not seriously considered agriculture as an aim or ideal of existence. We have not sent forth our imaginations to grasp a vision of agricultural development, either for humanity as a whole or for our own European race in the new continent that we have overrun but not yet occupied.