Lost Crops of the Incas

National Research Council Panel on Lost Crops of the Incas

These long-forgotten plants may play a key role in diversifying the world's food supply in years to come.

At the time of the Spanish conquest, the Incas cultivated almost as many species of plants as the farmers of all Asia or Europe. On mountainsides up to four kilometers high along the spine of a whole continent and in climates varying from tropical to polar, they grew a wealth of roots, grains, legumes, vegetables, fruits, and nuts.

Without iron, wheels, or work animals for plowing, the Indians terraced and irrigated and produced abundant food for 15 million or more people—roughly as many as inhabit the Andean highlands today. Throughout the vast Inca Empire, sprawling from southern Colombia to central Chile—an area as great as that governed by Rome at its zenith—storehouses overflowed with grains and dried tubers. Because of the Incas' productive agriculture and remarkable public organization, they were said to maintain three to seven years' supply of food in storage.

But Pizarro and most of the later Spaniards who conquered Peru repressed the Indians, suppressed their traditions, and destroyed much of the intricate agricultural system. They considered the natives to be backward and uncreative. Both Crown and Church prized silver and souls—not plants. Crops that had held honored positions in Indian society for thousands of years were deliberately replaced by European species (notably wheat, barley, carrots, and broad beans) that the conquerors demanded be grown.

Remaining in obscurity were at least a dozen native root crops, three grains, three legumes, and more than a dozen fruits. Domesticated plants such as oca, maca, tarwi, nũnas, and lucuma have remained in the highlands during the almost five hundred years since Pizarro's conquest. Lacking a modern constituency, they have received little scientific respect, research, or commercial advancement. Yet they include some widely adaptable, extremely nutritious, and remarkably tasty foods.

This botanical colonialism closed off from the rest of the world a major center of crop diversity. Food plants of Asia, Mexico, and especially of Europe became prominent; those of the Andes were largely lost to the outside world.

It is not, however, too late to rescue these foods from oblivion. Although most have been hidden from outsiders, they did not become extinct. Today in the high Andes, the ancient influences still persist with rural peasants,

The Inca Empire measured more than 4,000 kilometers from end to end. Superimposed on a map of modern South America, it would begin on Colombia's southern frontier, stretch southward along the coast and highlands of Ecuador and Peru, sprawl across highland Bolivia into northwestern Argentina, and reach down into central Chile to just below Santiago. This vast territory was probably the largest ever formed anywhere based on a "Bronze Age" level of technology.

who are largely pure-blooded Indian and continue to grow the crops of their forebears. Over the centuries, they have maintained the Incas' food crops in the face of neglect, and even scorn, by much of the society around them. In local markets, women in distinctive hats and homespun jackets (many incorporating vivid designs inspired by plant forms and prescribed by the Incas more than five hundred years ago) sit behind sacks of glowing grains, baskets of beans of every color, and bowls containing luscious fruits. At their feet are piles of strangely shaped tubers—red, yellow, purple, even candy-striped, some as round and bright as billiard balls, others long and thin and wrinkled. These are the "lost crops of the Incas."

That these traditional native crops have a possible role in future food production is indicated by the success of the few that escaped the colonial confines. Among the Incas' wealth of root crops, the domesticated potato, an ancient staple previously unknown outside the Andes, proved a convenient food for slaves in the Spanish silver mines and sailors on the Spanish galleons. Almost inadvertently, it was introduced to Spain, where, over several centuries, it spread out across Europe and was genetically transformed. Eventually, the new form rose to become the fourth-largest crop

*Harvesting quinoa grain (*Chenopodium quinoa*) in Ilave, Peru. Traveling through Colombia in the early 1800s, Alexander von Humboldt observed that quinoa was to the region what "wine was to the Greeks, wheat to the Romans, cotton to the Arabs." He was excited by the crop because at the time starvation was rampant all over the world, and he had gone to South America looking for new foods to combat it. Photo by M. Sayago, IAF.*

on earth. Other Andean crops that reached the outside world and enjoyed spectacular success were lima beans, peppers, and the tomato.

In light of this, it is surprising that more than thirty promising Inca staples remain largely restricted to their native lands and unappreciated elsewhere. Given research, these too could become important new contributors to the modern world's food supply.

The Andean Environment

The Andean region became an important center for domestication of crop species in large part because of its striking geographical contrasts. Along its western margin stretch narrow coastal deserts that are all but uninhabitable except where some forty small, fertile river valleys cross it. Behind this mostly barren plain towers the world's second-highest mountain range, the Andes, reaching an average of over 3,000 meters elevation. Its glacial heights were also uninhabitable, but intermontane valleys and basins are well suited to human occupation, and these became the home of the Inca rulers. Beyond the mountain valleys, on the eastern face of the Andes, are found subtropical cloud forests gently sloping into the Amazon jungle.

The Andean region was quite unlike the other regions where clusters of crops were domesticated. Here were no vast, unending plains of uniformly fertile, well-watered land as in Asia, Europe, or the Middle East. Instead, there was an almost total lack of flat, fertile, well-watered soil. Andean peoples grew their crops on millions of tiny plots scattered over a length of thousands of kilometers and perched one above another up mountainsides rising thousands of meters.

This complicated ecological mosaic created countless microclimates, including some of the driest and wettest, coldest and hottest, and lowest and highest found anywhere in the world. Perhaps no other contiguous region has such a broad range of environments as in the ancient Inca Empire. And the region is so fragmented that rainfall, frost, sunlight, and soil type can vary over distances less than a meter. For instance, a valley floor may have thick soils, abundant sunshine in the daytime, and severe frost at night, whereas immediately adjacent slopes may be thin-soiled, shaded, and frost-free.

To protect themselves against crop failure, ancient Andean farmers utilized all the microenvironments they could. Conditions causing poor harvests in one could produce bumper crops at another. Farmers deliberately maintained fields at different elevations, and this vertically diversified farming fostered the development of a cornucopia of crop varieties, each with slightly different tolerances to soil type, moisture, temperature, insolation, and other factors.

The resulting diversity of crops served as a form of farm insurance, but the differing growth cycles of different habitats also permitted work to be staggered and therefore more area to be cultivated.

*The zapallo (*Cucurbita maxima*) is only one of many squashes native to the Andes. This species, noted for its rich diversity, has given rise to numerous commercially successful squash varieties, including Acorn, Banana, Buttercup, and Hubbard.*

Inca Agriculture

Western South America's dramatic stage—coast, valleys, highlands, and cloud forest—formed the setting for the evolution of Andean civilization, which emerged some 4,500 years ago. On the semiarid coast, up the precipitous slopes, across the high plateaus, and down into the subtropical jungles of the eastern face of the Andes, dozens of cultures flourished and faded before the rise of the Incas about A.D. 1400.

The Incas inherited and built upon the products of thousands of years of organized human endeavor. It was they who, through military and diplomatic genius, first united a vast realm running the length of the Andes. Employing an inspired, if rigid, administration, they promulgated a social uniformity from their capital, Cuzco. The entire empire was a single nation, governed by the same laws, privileges, and customs.

The union within the Inca Empire was surprising because the various lands it covered were so vastly different: seared desert, saline flats, vertical valley walls, windswept barrens, triple-canopy jungle, glacial sands, floodplains,

Recreating Prehistoric Abundance

About 3,000 years ago, an ingenious form of agriculture was devised on the high plains of the Peruvian Andes. It employed platforms of soil surrounded by ditches filled with water. For centuries this method flourished because it produced bumper crops in the face of floods, droughts, and the killing frosts of those 3,800 meter altitudes. Around Lake Titicaca, remnants of over 80,000 hectares (200,000 acres) of these raised fields (*waru waru*) can still be found. Many date back at least 2000 years.

Now, in a dramatic resurrection, modern-day Peruvians working with archaeologists have reconstructed some of the ancient farms, and the results have been amazing. They have found, for instance, that this method can triple the yield of potatoes. In at least one experiment, potato yields outstripped those from nearby fields that were chemically fertilized. As a result of such observations, local farmers have begun restoring the ancient *waru waru* on their own. Government-sponsored restoration projects are also under way.

The combination of raised beds and canals has proved to have remarkably sophisticated environmental effects. For one thing, it reduces the impacts of extremes of moisture. During droughts, moisture from the canals slowly ascends to the roots by capillarity, and during floods, the furrows drain away excess runoff. For another, it reduces the impact of temperature extremes. Water in the canals absorbs the sun's heat by day and radiates it back by night, thereby keeping the air warm and helping protect crops against frost. On the raised beds, nighttime temperatures can be several degrees higher than in the surrounding region.

For a third, it maintains fertility in the soil. In the canals, silt, sediment, nitrogen-rich algae, and plant and animal remains decay into a nutrient-rich muck. Seasonal accumulation can be dug out of the furrows and added to the raised beds, providing nutrients to the plants.

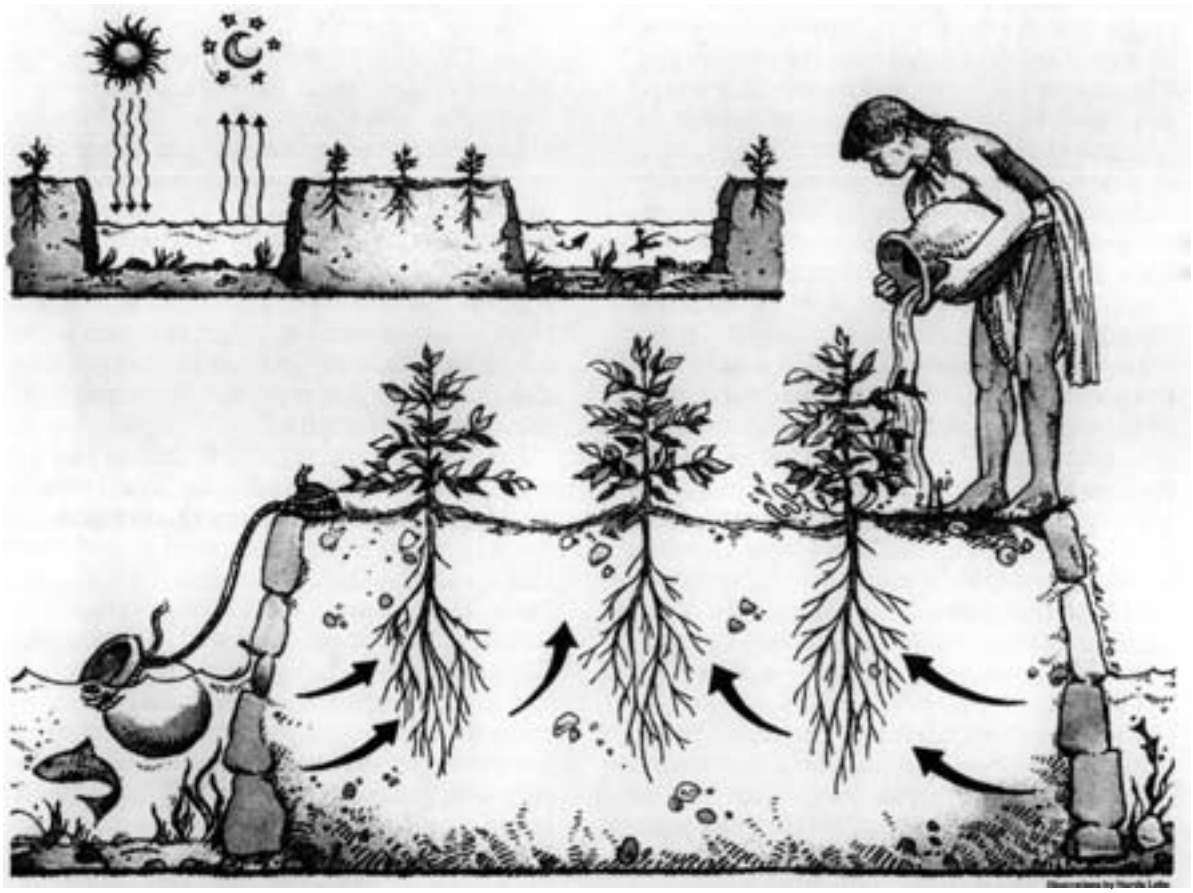
The prehistoric technology has proved so productive and inexpensive that it is seen as a possible alternative for much of the Third World where scarce resources and harsh local conditions have frustrated the advance of modern agriculture. It requires no modern tools or fertilizers; the main expense is for labor to dig canals and build up the platforms with dirt held in by blocks of sod on the sides.

saline crusts, perpetual snow, and equatorial heat. This diversity is reflected in the Incas' own name for their empire: Tahuantinsuyu—Kingdom of the Four Corners—coast, plateau, mountain, and jungle. Yet the Incas learned to manage the desolation and the variety of these most demanding habitats, and they made these regions bloom.

This success was owing to several factors.

First, the Incas were master agriculturalists. They borrowed seeds and roots from their conquered neighbors and forcibly spread a wealth of food crops throughout their empire, even into regions where they were previously unknown. To enhance the chances of success, the Incas purposefully transplanted the plants with their farmers, thereby spreading both the species and the knowledge of how to cultivate them.

Second, the Incas created a vast infrastructure to support (or perhaps to enforce) the empire's agriculture. For example, they modified and conserved steeply sloping erodible terrain by constructing terraces and irrigation works, and by fostering the use of farming systems that attenuated the extremes of temper-



Water in the canals absorbs the sun's heat by day and radiates it back by night, helping protect crops against frost. The more fields cultivated this way, the bigger the effect on the microenvironment. The platforms are generally 4 to 10 meters wide, 10 to 100 meters long and about one meter high, built with soil dug from canals of similar size and depth. Sediment in the canals, nitrogen-rich algae, and plant and animal remains provide fertilizer for crops. Illustration by Narda Lebo.

ature and water. These included, for example, ridged fields and planting in small pits. In some areas, Inca terraces and irrigation systems covered thousands of hectares. Many are still in use.

Third, contributing to the infrastructure were roads and footpaths that provided an extensive system for transporting products to all corners of the realm. As a result, massive amounts of food could be moved on the backs of llamas and humans—for example, corn into the highlands, quinoa to the lowlands, and tropical fruits from the eastern jungles to the heights of Cuzco. To implement this superb organization without paper or a written language, a mathematical system was developed that used knots tied in strands of yarn (quipu). The code of the knots was memorized and so can never be solved. Today, they cannot be "read," but they resemble the digital system of computers; the Incas could maintain highly elaborate and complex records and accounts.

Further, the roads and footpaths made possible the exchange of information. Instructions and advice were carried quickly throughout the empire by an organized corps of runners. In this way, Inca sages sent predictions of the weather for the upcoming cropping season to and from all regions. The predictions were based on natural indicators such as the behavior of animals, the flowering of certain plants, and the patterns of the clouds and rainfall. The Incas were familiar, for example, with the phenomenon known as "El Nino" that periodically changes the ocean currents off the coasts of Peru and Ecuador, wreaking havoc with regional weather.

The Incas also developed methods for preserving their harvests for years, when necessary. It is estimated that in the central highlands of Peru alone there were tens of thousands of large, rock-walled silos and warehouses. Such stores were filled each year with dried and salted meat (called "charqui," the source of the English word "jerky"). They also contained roots preserved by freeze-drying. When potatoes, for example, had been harvested at the highest altitudes, they were spread out and left overnight in the freezing air. The next day, men, women, and children walked over the partly withered tubers, squeezing out the moisture that had been released by the freezing. The same process was repeated over several nights and days, after which the potatoes were completely dehydrated and could be stored safely.

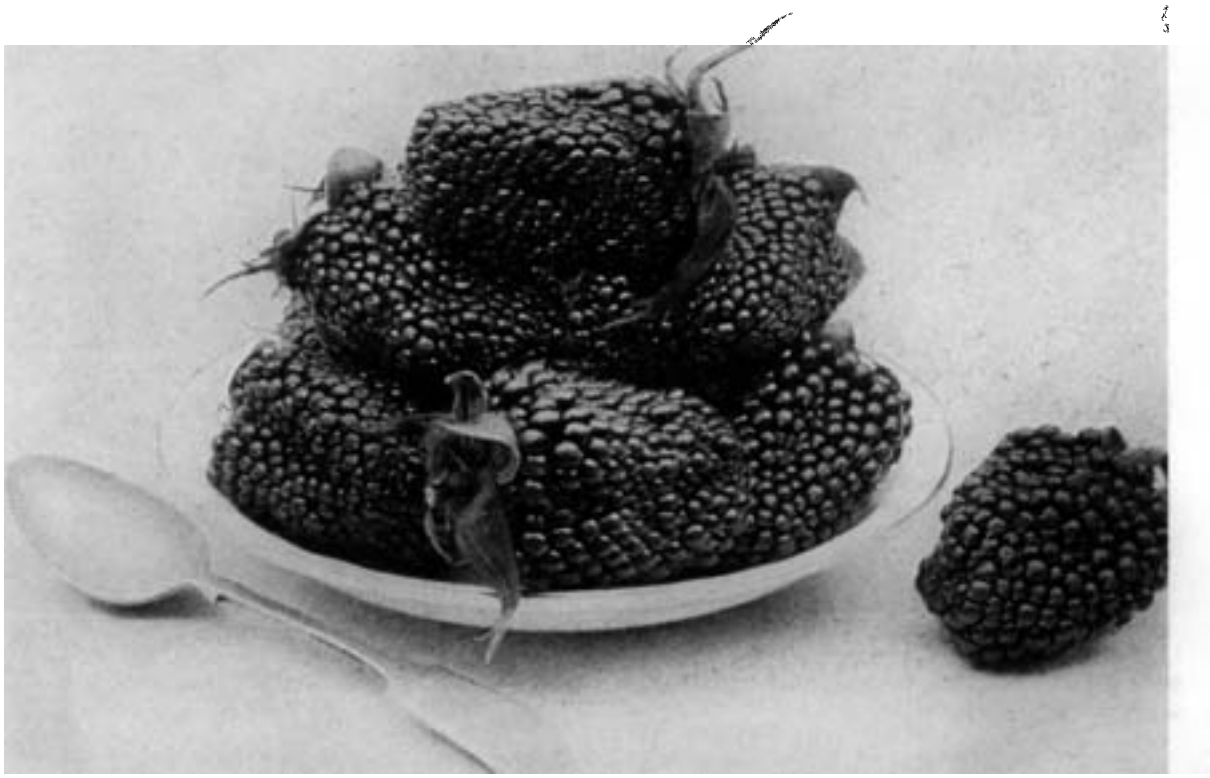
The Incas' Descendents

For all its size and splendor, the Inca Empire endured for only a century, and it was crumbled by fewer than two hundred Spanish adventurers. Today the region of the empire—the highlands from Colombia through Chile—is one of the world's most depressed areas. The infant mortality rate is one of the highest on the South American continent—more than one-fourth of the children die before their first birthday, a rate more than twice that of Latin America at large and about fifty times that of Sweden. Only one in seven homes has potable water, and only one in forty has indoor plumbing. Add to this the disruption caused by guerrillas, who have launched an armed campaign of terror in the Peruvian highlands, and it is no surprise that massive migration from the countryside to the cities has occurred.

Exacerbating the highlands' difficulties are cultural and ethnic divisions. The Indians, who make up about half of the population, live a life apart from the modern sector. Most still speak Quechua, the *lingua franca* of the Incas; a few around Lake Titicaca on the Peru-Bolivia border speak Aymara, an even older language. The Indians' rural lives have not changed appreciably for generations.

On the other hand, the whites and mestizos (persons of mixed European and Indian ancestry), who make up the other half of the population, speak Spanish and live in a modern urban world that is undergoing rapid change.

The classes, therefore, are separate and unequal. And a concomitant notion is that their food plants are separate and unequal as well. It may seem irrational, but crops the world over are stigmatized by the prejudices held



*The giant Colombian blackberry (*Rubus macrocarpus*) is one of the biggest berries in the world, almost too large to be taken in a single mouthful. Photo by Wilson Popenoe © National Geographic Society, 1926.*

against the peoples who use them most.

Over the centuries, the Spanish view that native crops are inferior to such European crops as wheat, barley, and broad beans has persisted. Indian foods are still equated with lower status. The conquistadores would undoubtedly be amazed to see potatoes, tomatoes, peppers, and limas contributing significantly to modern Spain's cuisine. But they would see that their prejudices against oca, tarwi, quinoa, and dozens of other Inca foods are still largely in place in South America.

Future Beyond the Andes

It is in the Andes that the plants have their greatest potential, especially for developing food products for malnourished segments of the population. However, they also promise to become useful new crops for other developing regions of the world, such as the tropical highlands of Asia, Central Africa, and Central America. In addition, they have notable promise for some industrialized regions, such as the United States, Europe, Japan, and Australasia. In fact, one country outside the Andes already has had considerable experience and success with them—New Zealand.

The reason these plants could have this wide ecological adaptation is that, although the Inca Empire stretched across the equator, a majority of its peoples actually dwelt more than three kilometers above sea level where bone-cracking cold descends at sunset, and the climate is more temperate than tropical. As a result, these crops in general have many

*Ahipa (*Pachyrhizus ahipa*) is one of the least known, but most interesting, of the plant kingdom's edible roots. The plants shown here were grown in Denmark, an indication that ahipa probably can be produced as a food crop in many places outside the Andes. Photo by F. Sarup.*

*Kiwicha "champion" Luis Sumar Kalinowski with a seedhead of one of his advanced lines of kiwicha (*Amaranthus caudatus*). Photo by Noel Vietmeyer.*

characteristics that have adapted them for cultivation in regions well outside the heat of the tropics. However, additional uncertainties exist when a crop is to be transplanted from one part of the world to another—for example, day length (photoperiod) dependence, which could be particularly troublesome.

Because the plants are native to latitudes near the equator (where the day and night lengths are equal year-round), some will not reach maturity during the long summer and fall days of the temperate zones. This difficulty has proved surmountable for potatoes, tomatoes, peppers, and lima beans, but it still could take growers some time to locate varieties or genes that can allow each of the crops described below to be grown as far from the equator as North America, Europe, Japan, and Australasia.

Difference in sensitivity to cold is another possible problem. Although the temperature variation in the Andean highlands often runs from a few degrees of frost at night to shirtsleeve temperatures at midday, the frosts in the Andes are extremely dry, and they rarely form ice on the plants. Therefore, whether frost-tolerance data recorded in the Andes can be extrapolated to other areas is uncertain.

Nonetheless, the global promise of these plants is very high. In the last few centuries the tendency has been to focus on fewer and fewer species, but today many ancient fruits, vegetables, and grains are finding new life in world markets. This is heartening, because to keep agriculture healthy and dynamic, farmers everywhere need plenty of options, especially now when markets, climates, national policies, scientific understanding,

and technologies are changing at a rapid pace.

The necessary next steps toward crop development and exploitation are often interdisciplinary, involving diverse interests such as genetics, processing, marketing, advertising, and technical development from the farm to the exporter.

Developing the lost crops of the Incas is the kind of research that scientists should undertake. In the process, they will rediscover the promise of these crops the Spanish left behind. The Inca Empire's grains, tubers, legumes, fruits, vegetables, and nuts are an enduring treasure for the Andes and for the rest of the world. Millions of people should quickly be introduced to these neglected foods of a remarkable people.

A summary follows of the "lost crops" of the Incas, selected by the National Research Council Ad Hoc Panel.

*Ulluco (*Ullucus tuberosus*) produces brightly colored tubers that are a staple food in many regions of the Andes.*

ROOT CROPS

Achira (*Canna edulis*, Cannaceae). Achira looks somewhat like a large-leaved lily. Its fleshy roots (actually rhizomes), sometimes as long as an adult's forearm, contain a shining starch whose unusually large grains are actually big enough to see with the naked eye. This starch is easily digested and is promising for both food and industrial purposes.

Ahipa (*Pachyrhizus ahipa*, Leguminosae). Ahipa is a legume, but unlike its relatives, the pea, bean, soybean, and peanut, it is grown for its swollen, fleshy roots. Inside, these tuberous roots are succulent, white, sweet, pleasantly flavored, and crisp like an apple. An attractive addition to green salads and fruit salads, they can also be steamed or boiled and have the unusual property of retaining their crunchy texture even after cooking.

Arracacha (*Arracacia xanthorrhiza*, Umbelliferae). Above ground, this plant resembles celery, to which it is related. Below ground, however, it produces smooth-skinned roots that look somewhat like white carrots. These roots have a crisp texture and a delicate flavor that combines the tastes of celery, cabbage, and roasted chestnut. They are served boiled or fried as a table vegetable or are added to stews.

Maca (*Lepidium meyenii*, Cruciferae). Maca is a plant that resembles a radish and is related to cress, the European salad vegetable. Although its edible leaves are eaten in salads and are used to fatten guinea pigs, it is most valued for its swollen roots. Resembling brown radishes, the roots are rich in sugars and starches and have a sweet, tangy flavor. Dried, they can be stored for years.

Mashua (*Tropaeolum tuberosum*, Tropaeolaceae). The well-known garden nasturtium was a favorite Inca ornamental, and at high altitudes in the Andes, its close relative, mashua, is a food staple. Farmers often prefer mashua to other tubers because it requires less labor and care to grow, and it can be stored in the ground and harvested when needed.

Mauka (*Mirabilis expansa*, Nyctaginaceae). Mauka has thick stems and yellow or salmon-colored fleshy roots that make it a sort of cassava of the highlands. The plant was unknown to science until "discovered" in Bolivia in the 1960s, and it now has also been found in remote mountain fields of Ecuador and Peru. If placed in the sun and then put in storage, the tubers turn very sweet, like sweet potatoes.

Oca (*Oxalis tuberosa*, Oxalidaceae). An exceptionally hardy plant that looks somewhat like clover, oca produces an abundance of wrinkled tubers in an array of interesting shapes, and in shades from pink

to yellow. In the Andean highlands, it is second only to the potato in amounts consumed, and is still a staple for Peruvian and Bolivian Indians living at high altitudes. The firm white flesh has a pleasant, sometimes slightly acid taste.

Potatoes (*Solanum* species, Solanaceae). The common potato became one of the twenty or so staple crops that feed the whole world. Collectively, these are adapted to a wide array of climates and provide a genetic source of diversity, disease resistance, and new crops. Many have unusual and marketable properties. Some are golden yellow inside, a number have a decidedly nutty taste, and almost all have more concentrated nutrients than the common potato.

Ulluco (*Ullucus tuberosus*, Basellaceae). Some of the most striking-looking roots in Andean markets are ullucos. They are so brightly colored—yellow, pink, red, even candy-striped—that their waxy skins make them look almost like plastic imitations. Once a staple in the Inca diet, ulluco is one of the few indigenous crops that has increased its range over the last century. In some areas, it vies with the potato as a carbohydrate staple.

Yacon (*Polymnia sonchifolia*, Compositae). Yacon is a distant relative of the sunflower. Grown in temperate valleys from Colombia to northwestern Argentina, it produces tubers that on the inside are white, sweet, and juicy, but almost calorie-free. Because of their succulence, they are eaten raw and are pleasantly refreshing; they are also eaten cooked. In addition, the main stem is used like celery, and the plant shows promise as a fodder crop.

*Mashua tubers (*Tropaeolum tuberosum*) thrive in the high cold altitude of the Andes. The plant requires little care and can be stored in the ground for months. Photo by Wilson Popenoe © National Geographic Society, 1926.*

GRAINS

Kaniwa (*Chenopodium pallidicaule*, Chenopodiaceae). This broad-leaved plant produces one of the most nutritious of all grains, with a protein content of 16 to 19 percent and an unusually effective balance of essential amino acids. It flourishes in poor rocky soil at high elevations, usually surviving frosts that kill other grain crops, and outyielding them in droughts. Incredibly, it thrives where frosts occur nine months of the year.

Kiwicha (*Amaranthus caudatus*, Amaranthaceae). The seeds of the amaranth, an almost totally neglected grain crop, have high levels of protein and the essential amino acid, lysine, which is usually lacking in plant protein. Kiwicha protein is almost comparable to milk protein (casein) in nutritional quality, and it complements the nutritional quality of foods that normally would be made from flours of corn, rice, or wheat. This makes kiwicha particularly beneficial for infants, children, and pregnant and lactating women.

Quinoa (*Chenopodium quinoa*, Chenopodiaceae). Although the seed of this tall herb is one of the best sources of protein in the vegetable kingdom, quinoa is hardly known in cultivation outside its upland Andean home. However, experience in the United States and England shows that the grain is readily accepted by people who have never tasted it before. Quinoa can be grown under particularly unfavorable conditions, at high elevation, on poorly drained lands, in cold regions, and under drought. Much has already been learned about this plant, which is becoming a commercial success outside the Andes.

LEGUMES

Basul (*Erythrina edulis*, Leguminosae). Basul is a common leguminous tree of the Andean highlands. It is unusual in that it produces large edible seeds and is one of the few trees that produces a basic food. Accordingly, it has promise as a perennial, high-protein crop for subtropical areas and tropical highlands. Beyond its use in food production, it is also a promising nitrogen-fixing tree for use in reforestation, beautification, erosion control, and forage production.

Nũnas (*Phaseolus vulgaris*, Leguminosae). The nũna is a variety of the common bean, but it is the bean counterpart of popcorn. Dropped into hot oil, nũnas burst out of their seed coats. The popping is much less dramatic than with popcorn but the product has delightful flavor and a consistency somewhat like roasted peanuts.

*Basul (*Erythrina edulis*) is a bean that grows on trees. Its extremely large seeds have a pleasant, slightly sweet flavor and are usually eaten like lima beans. They are also used in candies. Photo by Wilson Popenoe © National Geographic Society, 1926.*

Tarwi (*Lupinus mutabilis*, Leguminosae). This lupin is one of the most beautiful crops, and its seeds are as rich as, or richer in protein than peas, beans, soybeans, and peanuts—the world's premier plant-protein sources. Also, they contain about as much vegetable oil as soybeans. Tarwi has been held back mainly because its seeds are bitter. The Indians soak them in running water for a day or two, to wash out the bitterness. Geneticists in several countries have recently developed bitter-free varieties that need little or no washing.

VEGETABLES

Peppers (*Capsicum* species, Solanaceae). Chilies and sweet peppers have become the most widely used spices in the world, but hidden in the Andes are several more domesticated peppers as well as some wild species. All of these are employed by local people, and they promise to add new pungency, new tastes, and new variety to many of the world's cuisines.

Squashes and Their Relatives (*Cucurbita* species, Cucurbitaceae). Several of the fruits variously known as pumpkins, squashes, gourds, or vegetable marrows have their origins or greatest development in the Andes. These and some lesser-known botanical relatives are robust, productive crops, especially suitable for subsistence use. Many are little-known elsewhere and offer promise of new and better foods for scores of countries.

FRUITS

Berries. Along the length of the Andes are found several dozen localized berry fruits. These include relatives of raspberry and blackberry (*Rubus* species, Rosaceae), blueberry (*Vaccinium* species, Ericaceae), and some small berries (*Myrtus* species, Myrtaceae) that are rather like mini guavas.

Capuli Cherry (*Prunus capuli*, Rosaceae). The black cherries that are found throughout the Americas reach their best development in the Andes, where the capuli is a popular city and backyard tree. The cherrylike fruits are found in the markets three or four months of the year. Some are large, sweet, fleshy, and said to be at least as good as the traditional cherry.

Cherimoya (*Annona cherimola*, Annonaceae). Of all the Inca fruits, only the cherimoya is cultivated substantially outside the Andes. It is grown commercially in Spain, southern California, and a few other places. Such interest is understandable. Inside the thin greenish skin of the cherimoya is a delicious, sweet, and juicy flesh with a creamy, custardlike texture. Its unique flavor tastes like a subtle blend of papaya, pineapple, and banana.

Goldenberry (*Physalis peruviana*, Solanaceae). A relative of the North American husk tomato, the goldenberry is fresh-tasting and makes one of the world's finest jams. Growing under harsh conditions, it provides a wealth of yellow, marble-sized fruits that are beginning to attract international acclaim for their flavor and appearance.

Highland Papayas (*Carica* species, Caricaceae). Although the papaya is one of the premier fruits of the world, its botanical cousins of the Andes are all but unknown. They, too, have much promise, and they may extend the cultivation of papayalike fruits into cooler areas than is now possible.

*Although many species of wild berries are found in the Andes, the mora de Castilla (*Rubus glaucus*) is the most famous and popular. This Andean counterpart of the loganberry could have a bright future. Test samples of its high-quality, deep-red juice have been well received at a large U. S. fruit-drink corporation. This product might prove valuable for giving pallid juices a rich ruby red color. Photo by Wilson Popenoe © National Geographic Society, 1926.*

Lucuma (*Pouteria lucuma*, Sapotaceae). This fruit can be considered a "staple fruit." Unlike oranges or apples, its fruits are dry, rich in starch, and suitable for use as a basic, everyday carbohydrate It has been said that a single tree can feed a family year-round. The fruits are often eaten fresh and are very popular in milkshakes, ice cream, and other treats. Dried, they store for years.

Naranjilla (*Solanum quitoense*, Solanaceae). Related to, but wholly unlike, tomatoes, this fruit is highly esteemed in Peru, Colombia, Ecuador, and Guatemala, but virtually unknown elsewhere. The delicious, refreshing juice of the naranjilla is one of the delights of the northern Andes, and it could become popular in African and Asian tropics, where the plant could conceivably flourish.

Pacay (*Inga* species, Leguminosae). Among the most unusual of all fruit trees, pacay produces long pods filled with soft white pulp. This pulp is so sweet that the pods have been called "ice-cream beans." Not only are the fruits attractive and popular, this nitrogen-fixing tree is extremely promising for reforestation, agroforestry, and the production of wood products.

Passion Fruits (*Passiflora* species, Passifloraceae). This exotic fruit is becoming popular in Europe, North America, and other places. With its concentrated perfume and flavoring ability, passion fruit "develops" the taste of bland drink bases, such as apple juice or white grape juice. So far, all commercial developments have been based on a single Brazilian species. In the Andes there are scores of other species, some of which are reputed to be superior to the Brazilian one.

Pepino (*Solanum muricatum*, Solanaceae). A large, conical, yellow fruit with jagged purple streaks, pepino's mellow flesh tastes like a sweet melon. It is beginning to enter international commerce. Already gaining popularity in New Zealand and Japan, the delicate pepino seems destined to become a benchmark for premium fruit production.

Tamarillo (*Cyphomandra betacea*, Solanaceae). Inca gardens high on the mountainsides contained small trees that bore large crops of egg-shaped "tomatoes." Today these tree tomatoes remain one of the most popular local fruits. They have bright, shiny, red or golden skins and can be eaten raw or cooked or added to cakes, fruit, salads, sauces, or ice cream. The succulent flesh looks somewhat like that of the tomato, but it is tart and tangy and has a piquancy quite its own.

NUTS

Quito Palm (*Parajubaea cocoides*, Palmae). The streets and parks of the city of Quito are lined with an elegant palm that seems out of place because Quito is one of the highest cities in the world and has a cool climate. The palm produces many fruits that look and taste like tiny coconuts. They are so popular that only early risers can find any left on the streets.

Walnuts (*Juglans neotropica*, Juglandaceae). While most walnut species are natives of the Northern Hemisphere, a few occur in the Andes. They are common backyard and wayside trees, and at least one of these is a promising timber and nut tree. In New Zealand, this species has grown unusually fast for a walnut, and its nuts have a fine flavor.

*The cherimoya (*Annona cherimola*), universally regarded as a premium fruit, has been called the "pearl of the Andes," and Mark Twain declared it to be "deliciousness itself!"*

This article was reprinted from *Lost Crops of the Incas: Little-Known Plants of the Andes with Promise for Worldwide Cultivation.* The book makes up the report of an Ad Hoc Panel of the Advisory Committee on Technology Innovation Board on Science and Technology for International Development, established by the National Research Council. It was first published in 1989 by the National Academy Press, Washington, D. C. Copies of the book are available at the Arnold Arboretum Bookshop or can be obtained for $19.95, prepaid, from:

National Academy Press
2101 Constitution Ave., N. W.
Washington, D.C. 20418