Technical Note # 91

Underutilized Crops for Small Farm Abundance

What's Inside:

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published 2018

all photos were taken by ECHO staff unless otherwise noted

Examples of underutilized crops

INTRODUCTION

Traditional diets included a wide variety of ingredients from myriad wild and domesticated plants. Regional cuisines were shaped by native species in their local environment and by gradually-adopted plants from distant places. The modern global food system and market pressures have reversed this trend, so that today's diets rely on a dwindling number of crops for a growing number of people. This has profound effects on health and leads to dependence on unstable commodity markets. Malnutrition and food insecurity are critical issues for society's most vulnerable citizens.

This *Technical Note* (*TN*) will explore the unique plants that are used around the world to add variety and dependability to diets. Some species are wild or naturalized and can be found in forests, fields, and wetlands. Some are old cultivars of widely grown crops that have fallen out of use. Others are popular in one part of the world, but could be a valuable contribution to diets around the globe. Many have multiple uses and benefits. An essential part of ECHO's mission is to make seeds or cuttings of these traditional plants available to at-risk communities.

This *TN* addresses underutilized crops from the perspective of the smallholder farmer and community-based development worker. It will not discuss national and international policies, or international genetic preservation efforts. It will discuss underutilized plants and climate change from the perspective of local- and farm-level resilience, but will not examine global mitigation and adaptation implications. Livestock, aquaculture, or marine species are not addressed in this *TN*.

What's in a name?

The plants described in this *TN* fall into a category of agriculture with a confusing assortment of names, including *neglected and underutilized crops* (*NUC*s), *minor, marginalized, underexploited, abandoned, underdeveloped*, *lost,* and even *orphaned*. Such terms have somewhat negative implications and do not convey these plants' importance in their places of origin, their unique qualities, and their increasing use in new lands. In this document, they will be referred to as *underutilized crops*. While still slightly negative in connotation, this term implies untapped future potential.

Globally, wheat, rice, maize, and potatoes supply more than 60% of people's calories (FAO 2016), and around 50 crops contribute 90% of total consumption (FAOSTAT). Although global hunger and food insecurity have declined in recent decades, around 800 million people still suffer from hunger. Rates of adult malnutrition, child and infant mortality due to malnutrition, and stunting and developmental delays continue to plague hundreds of millions of

people. Many modern diets are based on just one or two staple cereal grains that may lack the nutritional balance that a more diverse diet would provide. Underutilized crops are often loaded with vitamins and minerals and can be incorporated into local diets. Nutritious lesser-known or forgotten plants are gaining attention as a means of boosting childhood development and improving public health.

Use of underutilized crops often declines due to changes in farming practices, changes in market forces, and cultural erosion that results from modernization, migration, urbanization, and land degradation. For these and other reasons, nutritional, medicinal, and ceremonial knowledge is often not passed on to younger generations. Re-introduction and promotion of underutilized plants to young people are important ways to teach history and honor the past.

Some underutilized crops are widely grown and used in their centers of origin, but are "neglected" by regional and international markets. Crops not suited to long distance transport and commodification are often ignored by plant breeders and agricultural researchers, which limits the number of named cultivars and the creation of new varieties with traits suited to a broader range of growing conditions. Some highly nutritious plants could play a larger role in reducing malnutrition if they were eaten over a longer period of the year or if cultivars were available for different growing conditions. Work on developing such cultivars of underutilized crops is being done by institutions such as Crops for the Future, the United Nations Food and Agriculture Organization, the African Orphan Crops Consortium, and the World Agroforestry Centre.

BENEFITS AND ABUNDANCE

Food Security and Nutrition

Hunger and malnutrition can be long-term (chronic) or short-term (acute). In both cases, availability of food varies seasonally in quantity and quality. Annually, a season of scarcity often occurs after seeds of staple crops have been planted and the growing season has begun. Increasing the number of farm crops (agrobiodiversity) can extend the harvest season so that fresh produce is available over more of the year.

Underutilized crops can be "bridge crops," filling nutritional gaps in the annual dietary cycle. Some "spring" crops are harvested early, before primary crops are available. Others mature late in the growing season and keep well after harvest. Still others can be continuously harvested over weeks or months and act as a long-term nutritional supplement. A farm or garden diverse in both species and cultivars will produce over an extended period and will provide a diversity of nutrients.

Income

Seasonal variation in food supply affects livelihoods as well. Times of abundance, such as during the harvest and sale of staple crops, alternate with periods during which savings dwindle. Underutilized crops can improve livelihoods in two ways. First, income can be increased through specialty markets that pay a premium for unusual products or items available somewhat out of season. Second, money can be saved, and thus livelihoods improved, if underutilized crops feed the family during periods when food might otherwise need to be purchased.

Resilience

Smallholder farmers are particularly vulnerable to both local and external disruptions. Droughts, floods, pests, conflict, commodity price fluctuations, and inaccessible farm inputs can undermine family health and stability. Erratic weather patterns, including delayed start of the rainy season, a shorter rainy season, or sporadic rainfall, require even more attention to plantings that can be harvested during the hunger months. The best way to build family and community resilience is to create farmsteads that are self-reliant for basic food, fiber, and fuel needs. Integrating underutilized crops within the overall farming system creates local self-sufficiency by reducing dependence on off-farm inputs and markets.

Perennial crops, which are planted once but harvested for many years, are often able to survive severe weather. With perennial crops, farmers can expend less labor (for planting), extend the growing season, and protect soil and water resources. Examples of perennial use include woody fodder and fuelwood species that can be coppiced (species capable of regrowth after being cut close to the ground); living fences and productive hedge rows for field borders; perennial legumes; perennial edible greens; and trees and shrubs planted for diversified fruit and nut production.

Biodiversity

Increasing crop diversity leads to improved family resilience; it also creates an ecosystem beneficial to local fauna and flora. The microclimates and niches on a diverse farm provide important habitat for pollinators and other beneficial insects that are helpful for Integrated Pest Management (IPM). The wild plants that exist in a diverse landscape can be important hosts for beneficial insects and birds. They can also be sources of food and fodder.

Medicine

In many parts of the world, people use traditional medicines from native plants. These folk remedies are affordable and often the only treatment available. Some medicinal plants are collected from the wild and some are maintained in home gardens. After harvest, medicinal herbs can be made into value-added teas, infusions, and lotions that can be sold at local markets for supplemental income.

Cultural Preservation

The promotion of underutilized crops can help to preserve local indigenous knowledge that is rapidly being lost. Many once-popular plants are now considered quaint, primitive, or backward; some are regarded only as famine food or food for the poor. This type of stigmatization can be reversed, but reintroduction should include an emphasis on nutrition, self-reliance, and food sovereignty.

Be sure to promote indigenous knowledge respectfully. Research the historical uses, distribution, and ritual and cultural significance of plants being evaluated or promoted. Herbalists and wild food gatherers have helpful botanical knowledge. You might also approach historians and folk artists to learn about traditional uses of plants. For example, expert craftsmen know which colors can be derived from which plants, and how to prepare them. Programs intended to revive folk crafts with local youth sometimes have the unexpected benefit of also promoting underutilized plants.

Underutilized crops, in the form of traditional foods, can play an important role in situations of migration and displacement. Many people who migrate to new cultures and food systems wish to maintain vestiges of their homelands. Even migrants to urban areas can grow specialty crops in container and window gardens, or in community garden allotments. Passing on the tastes and smells of traditional cooking is fundamental to human culture.

Utilization of Marginal Lands

Many underutilized plants are hardy and can thrive with little attention or expense under harsh conditions. Species exist that are adapted to poor soils, rough terrain, and/or drought conditions. They can be grown on portions of farmsteads where staple crops will not flourish. Thus, they do not necessarily compete for land or interfere with conventional farming practices. Fence rows, hedges, edges of fields and forests, and even drainage ditches can be excellent niches. Also, many underutilized plants are adapted to shade and can be grown in the shadow of other crops.

CHALLENGES, CONCERNS, AND CAUTIONS

Cultural Constraints

Certain crops present unique challenges and obstacles to adoption. For example, the taste may be culturally unacceptable, or the crop may turn out to be a pernicious weed when planted outside its native range. Before introducing a crop to a new area, be sure to evaluate its cultural and ecological appropriateness.

As part of this analysis, look at the hunger and malnutrition issues in the area. Who in the community is most at-risk? Where are these households located? (Are they marginalized to the worst land?) When are the “hungry” months? Which nutritional elements are lacking (e.g. protein, vitamin A, iron, etc.)? What social factors are affecting the situation? Are the social constraints explicit or unconscious? How might these be altered, and what unintended consequences might result?

Within your context, consider people’s level of receptivity to a potential change or innovation. First determine if underutilized plants could improve conditions in a culturally sensitive way; if so, then proceed to choose an underutilized crop that would be ecologically and nutritionally appropriate. Understanding a community’s dynamics takes time. Patience and curiosity are needed to get to know people at all levels of society. Carefully observe and probe to discern underlying power dynamics and power brokers within the community. It also takes time to understand the present farming systems, how they have changed over time, and what pressures caused those changes. Introduction of a new crop plant might seem harmless, but innovation always brings unintended consequences and tensions.

Economic and Marketing Considerations

Before introducing a new crop, ask whether it is useful or profitable enough to warrant the space that other plants might occupy. New crops should not displace traditional income streams, require high inputs, be laborious to maintain, or create financial risk. They should grow fast and produce high yields in their first or second season, to prove their worth quickly. If a crop has low commercial value, is its contribution to family nutrition high enough to compensate? Is there a market for surplus production? Is adequate seed available to meet the need if the crop proves popular? New crops should also be easy to share through seed or cuttings so that curious neighbors can experiment with them. Does the new crop meet a demand or solve a problem? For instance, if livestock forage is inadequate during certain times of year, will the new crop be ready to harvest at that time?

If an underutilized crop is being considered for income generation, be sure to examine local and regional markets. It will not help to produce a bumper crop of something if it will never reach a market and be sold. Bringing a new product to market will be easier if it serves as an attractive substitute or alternative to a product already being sold in the market. Selling an entirely new product is more difficult. For it to succeed, the new product must fill an existing felt need and must be accessible to potential customers.

Antinutritional factors

Some plants contain chemical substances that impart an unpleasant taste, interfere with availability of nutrients to the body, and/or are toxic if consumed in high enough amounts. In many cases, cooking or other food processing methods can reduce or eliminate these substances. Take time to learn about the crops you are working with and exercise due caution. With respect to anti-nutritional factors in underutilized crops, problems are minimized by eating small amounts of diverse species, versus consuming large amounts of just a few crops.

Ecological Concerns

Throughout human history, deforestation, erosion, plant and animal extinctions, and changes to hydrology have resulted from conversion of forests, savannahs, and wetlands to agriculture. Underutilized crops are often remnants or survivors within diminished native landscapes. Often they survive because they are hardy and able to tolerate harsh conditions; these characteristics mean that, when introduced to new environments, they often out-compete existing plants and become invasive. Here are some ways to avoid introducing a crop that could harm native ecosystems:

- Do not introduce species that are known to become weedy. Agricultural authorities in some countries maintain lists of crops they consider to be invasive. There are also websites, such as PIER (Pacific Island Ecosystems at Risk), that can be searched to assess the potential of a given species to be invasive. Factors to take into account include, number of seeds produced, how seeds are dispersed, distance over which seeds are dispersed, longevity of seeds, and how competitive the plants are for light, nutrients and water.
- Avoid bringing in new varieties of existing species that could cross-pollinate with native varieties, thus changing their characteristics and interactions within the ecosystem.
- Follow local import/export laws, inspect propagules (seeds, seedlings, cuttings) when you receive them, and take any other precautions (e.g., purchasing from reputable sources or purchasing tissue-cultured plants) necessary to prevent the spread of pathogens or insect pests.

Some crops that are weedy/invasive are still useful. Tithonia (*Tithonia diversifolia*), for example, is considered by most to be a weed. Yet, it is used as a green manure, can be fed to animals, and has insecticidal properties. Introducing such crops to new areas is not recommended, especially if the negative impacts outweigh the benefits. However, if such plants are already present, consider ways in which they could be utilized without further negative impacts to the environment.

Figure 1. Flower and foliage of *Tithonia diversifolia*.
Source: Tim Motis

Ownership of Indigenous Plant Resources

Collecting plant resources for distribution outside their area of origin can violate farmers' sense of ownership of local resources. This is especially true if one or more of the following scenarios apply:

- Seeds or other propagation material are taken without permission.
- Plants or seeds are taken of wild species or those that are only found in a specific area or region.
- Plant materials taken are later patented, used for breeding purposes that farmers are unaware of, and ultimately sold for profit.

Even if you have no intentions of restricting plant ownership (e.g., taking material out of public domain), it is matter of good practice and common courtesy to respect local plant resources and those who are caretakers of them. Ask permission before collecting plant material from someone's land. If you ask farmers for seeds, be transparent and explain to them what you are planning to do with them. Before exporting seeds outside a region or country, consult agriculture authorities to find out about any plant species or landraces they consider to be national resources. Conflict can also be avoided by working with crops that are already being grown in many places around the world.

SELECTING UNDERUTILIZED PLANTS

Overall Process

When selecting underutilized crops for an area, begin by gaining an understanding of the local context. What are farmers growing already? What plant resources exist locally or in country? What crops are being sold and traded in local markets? What food production constraints do farmers face? What are the nutritional gaps in a community? In answering such questions, get as much input as possible from local farmers. Analyze the soil, climate, and pest conditions of an area and match those with species and varieties that are most likely to thrive in the new environment. Narrow your list of species and varieties further by taking into account the challenges, concerns and cautions discussed in the previous section.

Indigenous Crop Options

Some underutilized crops are native to an area, or have been there so long that they are now considered traditional. There may be good reasons that they are no longer widely used, but they also might have been neglected as new varieties and farming practices were adopted. Sometimes the "new" overshadows the value of the "old." A community may benefit from simply rediscovering existing but little-known resources. As mentioned earlier, be respectful of a community's sense of ownership of local plant resources.

You can locate and learn about indigenous underutilized plants in several ways. First, share meals with the elders of the community and ask many questions. Showing respect and curiosity for traditions is always welcome. Second, bring that same curiosity to local markets and befriend vendors of unusual vegetables, fruits, herbs, and spices. Third, learn about unusual plants you observe and how they are grown. Farmers love to share their knowledge and will welcome a visitor who comes to learn, but may be distrustful of a formal survey process. Fourth, organize a shared community meal with the express intent to learn about food traditions and rituals. If you ask to participate in the preparation for local festivals and ceremonies, you will be helpful while getting a behind-the-scenes glimpse at local traditions.

Exotic Crop Options

In all regions of the world, people grow crops that are not native to the area. Many of these exotics have become staple crops where they have been grown over time. Similarly, many underutilized crops are found in various countries around the world, far beyond their origins. As mentioned earlier, we want to avoid introducing an exotic crop that could become invasive in its new location.

List of Underutilized Crops from ECHO Seed Banks

Thousands of underutilized crops could be considered. The list below describes crops that have been successfully grown in many places. Depending on seed supplies (where ECHO is based in Florida and/or at one of our Regional Impact Centers), these are available from ECHO. To help simplify the task of selecting appropriate underutilized crops, the list below is followed by tables that organize underutilized crops by various categories (e.g., leafy vegetables, grains), with information on uses and special traits (e.g., nutritional factors). Tables include some species not carried by ECHO seed banks.

Each species description includes links to ECHO publications with further information. ECHO publications are abbreviated as follows: *ECHO Development Notes (EDN), Technical Note (TN), Research Note (RN), Asia Note (AN)*, and *Plant Information Sheet.*

Leafy greens

Chaya (*Cnidoscolus aconitifolius*) is native to Mexico. It is a fast-growing, drought-tolerant, perennial shrub, typically reaching 3 m in height. Chaya is sometimes referred to as the spinach tree, because of its abundant dark-green leaves. When cooked (necessary to reduce hydrocyanic acid), the young leaves and thick succulent stems make a tasty, nutritious, non-slimy vegetable. (EDN 136, TN 53, EDN 78)

Cranberry hibiscus (*Hibiscus acetosella*) and its sister species Roselle (*H. sabdariffa*) and Kenaf (*H. cannabinus*) are of African origin. Though believed to be a hybrid of the African wild hibiscus species, cranberry hibiscus is now known only as a cultivated plant. The leaves' reddish color and tangy flavor make a great addition to salads or stir-fries. (EDN 73)

Lagos spinach (*Celosia argentea*) has broad edible leaves with high protein content and is heavily cultivated as a source of spinach in Indonesia and in parts of Africa. Flowers and seeds are produced in dense spikes. In addition to leaves, young stems and young flower spikes can be eaten. (TN 56, PIS)

Katuk (*Sauropus androgynous*) is native to the lowland rainforest understory of the warm tropics. It is a familiar plant in home gardens from the wetter parts of southeast Asia, since it can survive hot and humid conditions, and even occasional flooding. This perennial plant is popular for its edible leaves and young shoots. (EDN 87, EDN 59, EDN 107)

Malabar spinach (*Basella alba*) is native to tropical Asia. It is grown widely in the tropics as a perennial and in warmer temperate regions as an annual. Malabar spinach plants are green or purplish vines with thick fleshy leaves. The leaves and young stems are an excellent hot-weather spinach substitute. Young leaves are eaten raw in salads, and leaves and young stems are cooked and eaten. (PIS, EDN 57)

Moringa (*Moringa oleifera*), is native to northwestern India. It is widely grown in other areas of the tropics, including tropical Asia, South and Central America, and many regions of Africa. Moringa has a variety of uses and has nutritious, edible leaves. Flowers and pods are also eaten by humans and animals. (EDN 104, EDN 109, EDN 90, RN 1)

Vegetable amaranths (such as *Amaranthus tricolor*) are abundantly cultivated in hot humid regions of Africa, Asia, and the Caribbean. They are grown for their protein-rich leaves and plant tops. The seeds can also be eaten, but grain amaranth species are much better sources of seeds. (PIS, TN 2)

Grains

Chia (*Salvia hispanica*) originated in southern Mexico and Guatemala. The Aztecs used chia for food, medicine, and oil. Chia seeds can be eaten raw or ground into flour and incorporated into bread or cakes. Chia grain stores well and, being highly nutritious with a mild flavor, can be added to other foods to boost nutrition. (EDN 110)

Grain amaranths (such as *Amaranthus hybridus*) are traceable to the ancient Aztec civilizations of Mexico. They are grown primarily for their highly nutritious seeds, but leaves may be eaten as spinach. (EDN 91, EDN 92, TN 2)

Job's tears (*Coix lacryma-jobi*) is a 1- to 2-m tall grass with origins in Southeast Asia. It is found throughout most of the tropics, often in wild stands along ditches and streams. The seeds--yellow, purple or brown depending on the variety—are often tear-shaped. (AN 13, EDN 120)

Quinoa (*Chenopodium quinoa*) was considered second in importance only to corn in the Incan Empire, which extended over much of the Andes Mountains in South America. It is a good option for cooler, high-altitude areas of the tropics. Traditionally, quinoa grain is toasted, ground into flour, or boiled and eaten like rice. Quinoa leaves can be eaten as a green vegetable, either fresh or cooked, and all parts of the plant can be used for animal feed. (EDN 46, PIS)

Legumes

Adzuki bean (*Vigna angularis*) has been cultivated for 2,000 years in eastern Asia, and is now cultivated all over Asia. The dried bean is boiled and eaten with rice, in stews, and puréed for desserts. Young tender pods can be eaten like snow peas or cooked like green beans. (TN 59)

Calliandra (*Calliandra calothyrus*) is a low-growing, many-branched shrub that grows quickly on poor soils. It is native to Central America and Mexico, and now cultivated in both Africa and Asia. Calliandra responds well to coppicing, is suitable for hedgerows of alley-cropping systems (adding nitrogen-rich leaf litter to the soil), and produces excellent firewood and charcoal. Fresh leaves are cut and carried as a high protein fodder for dairy cows, goats and sheep. (PIS)

Gliricidia (*Gliricidia sepium*) is indigenous to Mexico, Central America, the West Indies, and Columbia. Gliricidia is used as a shade tree for coffee and cacao and, as it easy to propagate from leafless sticks, it is commonly planted to form living fence posts. Used as a green manure, it increases soil organic matter and helps recycle soil nutrients as it produces leaf litter. Its ease of establishment and rapid growth make it a good candidate for planting along contours to prevent soil erosion. The wood is hard, very durable, and termite resistant. Older wood is especially good for fuel. (PIS, EDN 82)

Lablab bean (*Lablab purpureus*) can grow in a wide range of climatic conditions and soil types. It is widely cultivated throughout the tropics and subtropics, and grows wild in tropical Africa and India. Lablab may be grown as a vegetable or pulse for human consumption, or as animal forage or feed. The young pods, leaves and flowers are eaten as a cooked vegetable. Dried seeds are a good source of protein and can be eaten cooked, processed into bean cakes, fermented as tempeh, or sprouted and eaten fresh. Lablab bean plants may be grazed by cattle, sheep, pigs, and goats. (TN 73)

Mung bean (*Vigna radiata*) is cultivated most extensively in the India-Burma-Thailand region of Southeastern Asia. Grown principally for its high-protein seeds for human consumption, it can also be utilized as fodder for livestock or as a green manure. (EDN 93, PIS)

Rice bean (*Vigna umbellata*) is native to Southeast Asia where it is often relay-cropped with cereals like maize or rice. Farmers in eastern India commonly eat the green pods both raw and cooked as a vegetable. Unripe seeds are boiled and sold as snacks in village markets. Dried rice beans are cooked and eaten with rice. The plants and pods are fed to livestock after harvest. (PIS, EDN 83)

Tepary bean (*Phaseolus acutifolius*) is native to the arid regions of the southwestern United States. Today it is grown by the Hopi Indians and other indigenous groups. It is adapted to high temperatures and low soil moisture, and can produce a large crop of nutritious seeds with remarkably little rainfall. The dried seeds are cooked and eaten. (PIS)

Winged bean (*Psophocarpus tetragonolobus*) is intensively cultivated in Burma and India, and has been successfully introduced into Malaysia, Thailand, Bangladesh, West Africa, and the West Indies. This climbing vine produces edible nutritious leaves, flowers, pods, green seeds, and dried seeds. In some varieties, the tuberous roots are also edible. (EDN 97, TN 33)

Yardlong bean (*Vigna unguiculata* subsp. *sesquipedalis*) produces long, edible pods, and is a more heat tolerant alternative to green pole beans (*Phaseolus vulgaris*). Pod color and length depends on the variety. Most varieties grow as vines that need trellis support, although more bushy varieties do exist. Harvest pods frequently (at least weekly), while they are still tender and before the seeds fill out the pods. (PIS, EDN 60)

Vegetables

African nightshade (*Solanum scabrum*), an annual or short-lived perennial, originated in the warm, humid forests of West and Central Africa; in that area, it is one of the most important vegetables for home consumption and income production. The fresh leaves and young shoots are cooked for human consumption and also used as fodder for cattle and goats. The ripe fruit is not eaten in Africa but used as a medicine. (EDN 103, PIS)

Bitter gourd (*Momordica charantia*) is a very popular vegetable in Southeast Asia and China. It was first found growing in India. Immature gourds and tender vine tips are consumed as a cooked vegetable. Medicinal compounds from bitter gourd are being evaluated as a possible treatment for infectious diseases and diabetes. (PIS)

Gac (*Momordica cochinchinensis*) is a perennial vine from South and Southeast Asia. Its colorful fruits are very high in vitamin A and can be eaten fresh, cooked, or as a powder. (EDN 135)

Indian jujube (*Ziziphus mauritiana*), also known as pomme de Sahel, originated in central Asia. Jujube is now naturalized in tropical Africa, India, China and the Mediterranean. Indian jujube is most typically a spiny, evergreen shrub, but can grow into a tree up to 15 m in height. The fruit is oblong, shiny yellow to red/black, 6 cm x 4 cm with white, sweet, juicy flesh that is eaten fresh or dried. The leaves make good fodder for sheep and goats. (PIS)

Naranjilla (*Solanum quitoense*) is a small shrub that originated in Peru, Ecuador and southern Columbia. It is a good candidate for cooler, high-altitude parts of the tropics. The orange fruits are high in vitamin C and make good juice. (EDN 128, PIS)

Roselle (*Hibiscus sabdariffa*) is cultivated widely in the tropics and subtropics. Young shoots, leaves, and calyces are used as a cooked vegetable. The dried red calyces are commonly used with sugar to prepare a cold, sour, refreshing drink. Calyces can also be steeped for a hot tea. (PIS)

Spider Flower (*Cleome gynandra*) is an erect annual indigenous to Africa. Though it occurs as a weed or "volunteer crop" in many parts of the tropics, in countries such as Tanzania, spider flower is cultivated in household gardens as a valuable potherb or for animal fodder. Leaves, young stems, and flowers are edible and contain substantial amounts of vitamins A and C, iron, and calcium. Spider flower is often eaten with other foods, due to its bitter taste. (EDN 113)

Tamarillo (*Cyphomandra betacea*) is a small evergreen shrub or small tree. Native to the Andes, it grows in the subtropical zone at 1500 to 3000 m, but it can also be grown in hotter, more humid conditions. The oblong fruits are eaten fresh. (PIS)

Tithonia (*Tithonia diversifolia*), also known as Mexican sunflower or tree marigold, is a perennial shrub native to Mexico and Central America. Though considered a weed by many, it is often introduced for its attractive flowers and as a non-leguminous green manure. Tithonia is surprisingly high in phosphorus, as well as nitrogen and potassium. The shrub can also be used for animal fodder, compost, fuelwood, and insect control. It grows on most soils, can reach 3 m in height, and is moderately resistant to drought. (EDN 86, EDN 134)

Table 1. Examples of underutilized crops with multiple products.

Underutilized Crop	Plant Part	Value
Moringa (*Moringa oleifera*)	Leaves	Edible and highly nutritious, whether eaten fresh, cooked, dried, or powdered
	Seeds	Edible; can be used to treat water
	Roots	Medicinal applications
Breadfruit (*Artocarpus altilis*)	Immature Fruit	Edible starchy vegetable when boiled
	Mature Fruit	Edible raw or baked
	Latex	Glue; medicinal applications
	Trunk	Timber
	Leaves	Fodder; medicinal applications
	Seed	Edible boiled or roasted
	Flower	Edible boiled as a vegetable
Edible rapeseed (*Brassica napus*)	Seed	Oil (for cooking)
	Leaves	Fodder
	Whole plant	Cover crop
Calliandra calothyrus	Leaves	Fodder
	Trunk	Timber; fuel
	Whole	Shade for understory (coffee & tea)
Gliricidia/Madre de Cacao (*Gliricidia sepium*)	Leaves	Fodder
	Trunk	Timber; fuel
	Whole	Shade for understory (coffee, tea, cacao)
Tithonia (*Tithonia diversifolia*)	Leaves	Compost; fodder; integrated pest management

Table 2. Examples of leafy vegetables with potential value.

	Species Name	Common Name	Uses	Special Comments/Notes
Drought Tolerant	*Solanum americanum, S. scabrum, S. villosum*	African nightshade	Leafy vegetable	Because they contain solanine, which can be toxic, cook/boil the leaves and do not eat unripe berries.
	Celosia argentea	Lagos spinach	Leafy vegetable	
	Cleome gynandra	Spider plant	Leafy vegetable	Leaves rich in protein and vitamins; drought tolerant
	Cnidoscolus chayamansa	Chaya	Leafy vegetable	Boil edible parts (leaves, petioles, green stems) for 20 minutes to remove cyanide-containing compounds; shrub is drought tolerant
	Corchorus olitorius	Jute mallow	Leafy vegetable	
Intermediate	*Amaranthus spp.*	Amaranth	Leafy vegetable	Leaves rich in protein, minerals and vitamins A & C. young leaves can be eaten fresh, but older leaves should be cooked because of higher concentration of oxalates (an antinutrient that makes Ca and Mg less available to the body)
	Cucurbita spp.	Squash	Vegetable, leafy vegetable	
	Manihot esculenta	Cassava	Leafy vegetable, starchy tuber	Leaves must be boiled 35 min to remove cyanide-containing compounds
	Hibiscus acetosella	Cranberry hibiscus	Leafy vegetable	
	Ipomoea batatas	Sweet potato	Leafy vegetable, starchy tuber	Young leaves can be eaten fresh, but older leaves should be cooked because of higher oxalate concentrations (see note on Amaranth)

Humid Tolerant	*Sauropus androgynous*	Katuk	Leafy vegetable	100 g serving of fresh katuk leaves supplies 22% of the daily requirement for Vitamin A
	Brassica oleracea var alboglabra	Chinese kale	Leafy vegetable	
	Lepidium sativum	Garden cress	Leafy vegetable	
	Abelmoschus manihot	Hibiscus manihot	Leafy vegetable	
	Lycium chinense	Chinese Boxthorn	Leafy vegetable	
	Momordica charantia	Balsam pear	Leafy vegetable	
	Trichostigma octandrum	Haitian Basket Vine	Leafy vegetable	Discard water used to boil young leaves, to remove bitter flavor
	Perilla frutescens	Beefsteak plant	Leafy vegetable, medicinal	
	Gynura crepoides	Okinawa spinach	Leafy vegetable	
	Basella alba	Malabar spinach	Leafy vegetable	
	Psophocarpus tetragonolobus	Winged bean	Vegetable, leafy vegetable	
	Ipomoea aquatica	Water spinach	Leafy vegetable	On many invasive weed lists.
	Trigonella foenum-graecum	Fenugreek	Leafy vegetable	

Table 3. Examples of pulses with potential value.

	Species Name	Common Name	Use	Special Comments/Notes
Drought Tolerant	*Lablab purpureus*	Lablab/ Hyacinth bean	Pulse	
	Phaseolus acutifolius	Tepary bean	Pulse	
	Vigna angularis	Adzuki bean	Pulse	
	Vigna subterranea	Bambara groundnut	Pulse	Seeds are rich in protein (24%), containing more methionine (essential amino acid) than most grain legumes
Humid Tolerant	*Vigna umbellata*	Rice bean	Pulse	
	Vigna radiata	Mung bean	Pulse	
	Vigna unguiculata subsp. sesquipedalis	Yard long bean	Pulse	Immature fruit can also be eaten as a vegetable

Table 4. Examples of grains with potential value.

	Species Name	Common Name	Use	Special Comments/Notes
Drought Tolerant	*Sorghum bicolor*	Sorghum	Grain	Drought-tolerant
	Eleusine coracana, Panicum miliaceum, Pennisetum glaucum	Millet	Grain	Drought-tolerant
Intermediate	*Chenopodium quinoa*	Quinoa	Grain	High protein (15%)
	Salvia hispanica	Chia	Grain	
	Amaranthus hypochondriacus, A. cruentus and A. caudatus	Amaranth	Grain	High in lysine and sulfur-bearing amino acids that are limiting in other grains
Humid Tolerant	*Coix lacryma-jobi*	Job's tears	Grain	Grain is rich in calcium and contains more fat and protein than rice and wheat.Produces 2-4 tonnes/ha of nutritious grain rich in calcium and containing more fat (5.5%) and protein (15.8%) than rice and wheat (LuFeng *et al.*, 2008)

Table 5. Examples of fruits and vegetables with potential value.

	Species Name	Common Name	Uses	Special Comments/Notes
Drought Tolerant	*Ziziphus sp.*	Jujube	Fruit, fodder	
	Solanum aethiopicum Solanum macrocarpon	African eggplant	Fruit (mature)	
Intermediate	*Cucurbita spp.*	Squash	Vegetable, leafy vegetable	Younger leaves are more tender and have fewer spines/hairs than older leaves
	Solanum bataceum	Tamarillo	Fruit (mature)	Prefers higher elevation
	Malpighia glabra	Barbados cherry	Fruit (mature)	High in vitamin C (2000 mg/100 g fresh ripe fruit)
Humid Tolerant	*Hibiscus sabdariffa*	Roselle	Edible calyx	
	Solanum quitoense	Naranjilla	Fruit (mature)	
	Momordica cochinchinensis	Gac	Fruit (mature)	Edible seed membranes and oil produced from seeds are high in carotenoids
	Psophocarpus tetragonolobus	Winged bean	Vegetable, leafy vegetable	Humid-tolerant; needs trellis
	Solanum melongena	Asian eggplant	Fruit (mature)	
	Momordica charantia	Bitter gourd	Fruit (mature)	

Table 6. Examples of tuber and aroid crops with potential value.

		Species Name	Common Name	Uses	Special Comments/Notes
Drought Tolerant		*Solenostemon rotundifolius*	Hausa potato	Starchy tuber	
		Manihot esculenta	Cassava	Starchy tuber, leafy vegetable	Tuber and leaves must be processed to remove cyanide-containing compounds (e.g. by fermentation or boiling). Drought tolerant
	Humid Tolerant	*Dioscorea sp.*	Yams	Starchy tuber	Vines of wild forms of air potato (*D. bulbifera*) smother native vegetation.
		Ipomoea batatas	Sweet potato	Starchy tuber, leafy vegetable	
		Xanthosoma sp.	Cocoyam	Starchy corm, leafy vegetable	
		Colocasia esculenta	Taro/Dasheen	Starchy corm	

EVALUATION AND PROMOTION OF UNDERUTILIZED CROPS

Have you considered introducing one or more underutilized crops in your area? Start by acquiring seeds, seedlings, and cuttings; many of the ones mentioned in this Technical Note are available from ECHO. Then it is time to experiment. Start with a small planting near your home or on a project site, so that you can observe progress and pests daily. If the new crop grows well, fits the local diet, and stimulates local interest, you can find a local farmer to plant a trial plot. Be sure that this farmer has the curiosity that is characteristic of an early adopter. Minimize risk of crop failure by only planting on a small portion of a farmer's land.

Ideally trial plots will allow for comparisons. For example, the new crop can be planted next to a similar type of crop that is already grown in the area. You can also plant just the new crop, but treat sections of the plot differently: for example, irrigation vs. no irrigation; mulch vs. no mulch; or regular weeding vs. neglect. Small sample harvests could be taken at different times in the growing cycle. If such trials show promise, early adopters can encourage neighbors and family to try

their own experiments. Inviting new farmers to talk to early adopters and tour their plots is the simplest form of farmer-to-farmer learning and knowledge sharing.

Both early and late adopters will adapt new crops in unforeseen ways. Learn about and work with any existing mechanisms farmers use to evaluate and adapt new crops. Successful introductions are usually those that not only grow well but are also easy to prepare and incorporate into traditional foods. Innovations will also occur in the post-harvest preparation of new foods and in potential market opportunities. Please document these new uses and share them with the ECHO Network!

Encourage people to share seeds within the community, so that benefits are experienced by as many people as possible. Generosity with planting materials and practices will go a long way in avoiding jealousy and conflict. It will also prepare the community to try more underutilized crops in the hopes of shared prosperity.

REFERENCES

FAO 2016. *Save and Grow in practice maize, rice, wheat: A Guide to Sustainable Cereal Production*. Food and Agriculture Organization of the United Nations, Rome.

FAOSTAT. Food and Agriculture Organization of the United Nations, Statistics Division, Rome.

LuFeng, J. YanMei, Y. CaiXia, and H. YiFan. 2008. Analysis and evaluation of the nutritional components of Chinese *Coix lachryma-jobi* kernel resources. *Acta Nutrimenta Sinica* 30:102-105.

ADDITIONAL READING

ECHO Resources

Agricultural Options for Small Scale Farmers: Chapter 4 discusses many underutilized crop options

Edible Leaves of the Tropics: A book with comprehensive information on plants in the tropics that produce edible leaves

EDN 113: Focuses on indigenous food plants, with links to other resources.

TN 20: Contains information useful for identifying promising plants for the tropics.

TN 81: An introduction to tropical root crops

Non-ECHO Resources

Lost Crops of Africa series: Books on grains (Volume I), vegetables (Volume II) and fruits (Volume III)

Are Neglected Plants the Food of the Future?: A scholarly review of underutilized crops for diversifying human diets

Fighting Poverty, Hunger and Malnutrition with Neglected and Underutilized Species: An overview by Bioversity International of underutilized crops, detailing their importance, status in various parts of the world, challenges, and ways to promote them.

Living with the Trees of Life: A book that deals with rural agroforestry

Inviting All the World's Crops to the Table: A booklet highlighting traditional, underutilized crops.

Strengthening Informal Indigenous Seed Systems in Southeast Asia: A paper co-authored by ECHO staff that discusses indigenous vegetable crops while characterizing the informal seed system in parts of Southeast Asia

Lost Crops of the Incas: Focuses on underutilized crops for the Andes, a good resource for cooler areas.

CRC Handbook of Alternative Cash Crops: Presents information on 128 crops.

A Field Guide to Medicinal and Useful Plants of the Upper Amazon: Contains many helpful photos and explains uses of plants in the Amazon.

African Indigenous Vegetables: An overview of the Cultivated Species 2002

Global Research on Underutilized Crops: Reviews research trends and is written for those in a position to influence policy and research collaboration.

Databases

PROTA (Plant Resources of Tropical Africa)

Tropical Forages

HortPurdue Crop Index

Organizations devoted to underutilized crops:

Crops for the Future

Bioversity International

World Agroforestry Centre

Trees for the Future

AVRDC (now known as the World Vegetable Center)

ICARDA (International Center for Agricultural Research in the Dry Areas)

CIAT (International Center for Tropical Agriculture)

ICRISAT (International Crops Research Institute for the Semi-Arid Tropics)

IITA (International Institute of Tropical Agriculture)