ECHO® Development Notes

Edited by Dawn Berkelaar and Tim Motis | October 2015 | Issue 129

Permaculture In Development:
An introduction to permaculture and its application in agriculture development

By Brad Ward

Introduction

The word *permaculture* is mentioned with increasing frequency in speeches, books and magazine articles on sustainability and food security. What is permaculture? Is it a movement? A philosophy? Simply a set of design tools? In this article, I answer the above questions by looking at permaculture from a variety of angles. First, I briefly describe permaculture's history, underlying ethics, and key principles and common practices. Then I discuss common criticisms of permaculture and explain the underlying perspective that shapes its use in addressing a community's food, water and shelter needs (i.e., the lens through which a permaculturalist views development). Finally, I share how permaculture has influenced my own life and work, both as a Christian and as an agriculture development worker.

Figure 1: *The permaculture-designed community garden space at ECHO. Source: Betsy Langford.*

Definitions

The word permaculture, coined by its co-founder Bill Mollison, is formed from the words "permanent" and "agriculture." The concept of permaculture is difficult to explain in just a few words, because the term is used to describe (usually simultaneously) both a worldview/philosophy for living on the earth and a set of design principles and practices.

Bill Mollison emphasized the philosophical aspect in his definition: "Permaculture is a philosophy of working with, rather than against nature; of protracted and thoughtful observation rather than protracted and thoughtless labor; and of looking at plants and animals in all their functions, rather than treating any area as a single-product system" (Mollison 1988).

Rafter Ferguson, a well-regarded permaculture researcher and practitioner, has an elegantly simple way to frame the many aspects of permaculture: "Permaculture is meeting human needs while increasing ecosystem health" (Ferguson 2012). To guard against reductionism, Rafter adds a cautionary statement to his concise definition, saying, "I'm all for shorthand definitions in the right context as long as it's being used to communicate a principle rather than obscure fundamental complexity" (Ferguson 2013b).

My own definition of permaculture is as follows: *Permaculture is a cohesive set of ethics, principles and practices that help guide the stewardship of an ecosystem to ensure resilience and abundance to all its inhabitants*.

Permaculturalists and Permaculture Designers

The permaculture movement is very open-source and non-centralized. A person wanting to call him/herself a Permaculturalist or Permaculture Designer is expected to complete a Permaculture Design Course (PDC) led by a teacher or group of teachers with sufficient training and experience to teach the course. Courses are offered through universities, at small farms that have been designed around permaculture principles, and even in the backyards of urban/peri-urban permaculturalists. Each course includes 72 hours of instruction based on the main themes laid out in *Permaculture: A Designers' Manual* by Bill Mollison (1988). Courses can be structured many ways: intensive courses take place over nine consecutive days, weekend courses take place over several consecutive weekends, and online courses are typically nine weeks long.

Many people practice permaculture without calling themselves permaculture designers and without having taken a PDC. For example, ECHO's Global Farm in Fort Myers, Florida, is an excellent example of applied permaculture practice, even though it has not been specifically designed according to permaculture principles. Many ECHO Technical Notes and articles have detailed the application of permaculture principles without using the "permaculture" label.

Featured in this EDN

ECHO is a global Christian organization that equips people with agricultural resources and skills to reduce hunger and improve the lives of the poor.

ECHO
17391 Durrance Road
North Fort Myers, FL 33917 USA
p: 239-543-3246 | f: 239-543-5317
www.ECHOcommunity.org

Key Figures and Primary Source Literature

Bill Mollison (born in 1928) is considered to be the father of permaculture. In 1978, Mollison collaborated with David Holmgren to write a foundational book called *Permaculture One*. Mollison also wrote *Permaculture: A Designers' Manual*, published in 1988. This 400-page book lays down the foundational philosophies, principles and practices of permaculture. Mollison founded The Permaculture Institute in Tasmania, and created a training system to train others under the umbrella of permaculture.

David Holmgren (born in 1955) is a co-originator of the permaculture concept with Mollison. Holmgren is an Australian permaculture designer, ecological educator and writer. His 2002 book, *Permaculture: Principles and Pathways Beyond Sustainability*, provides what many view as a more accessible guide to the principles of permaculture. Holmgren refined those principles over more than 25 years of practice.

Two other authors whose ideas are featured prominently in permaculture concepts are P.A. Yeomans (1904-1984) and Masanobu Fukuoka (1913-2008).

P.A. Yeomans was an Australian inventor known for the Keyline system, used to develop land and increase its fertility. Yeomans' Keyline concepts are now part of the curriculum of many sustainable agriculture courses in colleges and universities across the world. Yeomans wrote four books: *The Keyline Plan*; *The Challenge of Landscape*; *Water for Every Farm*; and *The City Forest*.

Masanobu Fukuoka was a Japanese farmer and philosopher. He promoted no-till, no-herbicide grain cultivation farming methods, and created a particular method of farming, commonly referred to as "Natural Farming" or "Do-nothing Farming". Fukuoka authored several Japanese books, scientific papers and other publications, most notably *The One-Straw Revolution*.

Due to the recent growth in permaculture's popularity, many books have been written to help explain basic concepts or to drill deeper into a particular system and/or practice. An extensive list of permaculture books and websites can be found at the end of the article.

Permaculture as a movement

Permaculture practitioners and teachers think deeply about natural systems, and especially about human interaction with those systems. Because technology has increased the capacity for humans to make large-scale and rapid changes to entire ecosystems, permaculture practitioners often find themselves on the front lines of a debate that pits extractive greed against the long-term health of the planet. In this way, permaculture joins the larger movement of those who wish to conserve natural systems and mitigate/restore the damage done by decades of unbridled exploitation. Permaculture's voice in this movement is valuable because it offers positive, actionable design alternatives to the status quo.

Permaculture as a process for designing human community and natural ecosystems

Using a permaculture framework, the design process moves through several levels. It begins with ethics, then moves to principles, next to design strategies, and finally to technique or application.

I. Ethics

Permaculture, whether viewed as a philosophy, a movement or a design process, rests on three ethical pillars: 1) care for the earth; 2) care for people; and 3) set limits to consumption and reproduction, and redistribute surplus (Holmgren 2002). Most people can agree with the first two ethical statements, but the concepts of population control and redistribution are loaded with controversy. For this reason, many permaculture authors and teachers have simplified/modified the third ethical principle to "fair share" or "care for the future."

II. Principles – Bill Mollison

In *Permaculture: A Designers' Manual*, Mollison (1988) condensed the core principles of permaculture design into the following five statements [in bold, with elaboration from the author]:

1. **Work with nature rather than against**. This statement may seem obvious, but we humans tend to try and "have it our way" when it comes to the agriculture systems we develop. This often creates unnecessary failure, exorbitant use of natural resources, and potentially wide-spread ecological damage. Large-scale monocropping is a classic example of working against nature.

2. **The problem is the solution**. If we are willing to look at a problem from a variety of angles, we will discover that the "problem" is actually a resource for another part of the ecosystem. A good example of this is Mollison's well-known statement, "You don't have a snail problem, you have a duck deficiency!"

3. **Make the least change for the greatest possible effect**. Thoughtful interventions aimed at leverage points in an ecosystem yield the greatest returns for the time and resources invested. An example of this principle is S.A.L.T. (Sloping Agricultural Land Technology) for hillside farming. By planting trees along a contour (the leverage point), erosion is reduced, terraces are formed, and soil fertility is maintained—and possibly even enhanced.

4. **The yield of a system is theoretically unlimited.** This principle might also be expressed by saying that it is only our knowledge and imagination that limit the sustainably productive potential of an ecosystem. A permaculture designer works to create layers of symbiotic relationships in an ecosystem. This concept is well-displayed in agroforestry systems, in which multiple stories of species work together to protect and serve each other, increasing both the total potential yield and (often) the individual yield of each component. Function stacking, another concept that illustrates this principle, refers to choosing plants and animals in a design that perform more than one function and yield more than one product. A flock of chickens is a good example of this idea; chickens provide food, feathers, manure, tillage, weed control, insect control, etc.

5. **Everything gardens (or modifies its environment)**. Every part of an ecosystem directly influences certain other parts of the system and has an overall influence on the system as a whole. In complex systems, changes bring unintended consequences.

Careful observation over a long period of time reduces unintended negatives.

III. Principles – David Holmgren

In his book *Permaculture: Principles and Pathways Beyond Sustainability* (2002), Holmgren expands the number of permaculture principles to twelve [in bold, with elaboration from the author]. His approach provides a more nuanced and systematic way to begin making stewardship decisions in complex and ever-changing ecosystems.

1. **Observe and Interact**. Spend a long time observing an ecosystem before starting to build or garden in it. Doing so will enable us to build or garden as efficiently and sustainably as possible.

2. **Catch and Store Energy**. Energy of all types flows into and out of all ecosystems. Make the most of these resources, and minimize/eliminate any losses. Energy resources include: sunlight; water; seeds; inherent heat (such as in stones and water); wind; and organic matter (in soil and compost).

3. **Obtain a Yield**. When growing plants for food, fuel, textiles and/or beauty, we want to obtain a yield. Good stewardship is about abundance and blessings we can share.

4. **Apply Self-Regulation and Respond to Open Feedback Loops**. Negative feedback can point to unsustainable methods, and probably means we need to do things a little differently. Excess positive feedback may hurt other systems. Our goal is balance. For people accustomed to viewing agriculture projects and/or development work as a series of problems to be solved, reading the negative feedback signals can seem fairly straightforward. Evaluation of excessive positive feedback can be harder to observe and discern. For example, for decades, mega-scale monocropping symbolized best-practice modern agricultural productivity. The negative environmental and human impacts of these systems were easy to miss, and remain easy to rationalize in the light of their enormous capacity to provide the raw materials for cheap calories and corporate profits. It is difficult in the dominant system to say "no thanks" to short term gains (excess positive feedback), even when we recognize that there will be a cost to both people and the planet.

5. **Use and Value Renewable Resources and Services**. Conserve non-renewable resources, and always seek to restore resources. Expand our thinking about what could be a resource.

6. **Produce No Waste**. Ideally, everything that is needed is made on site, and all byproducts become inputs for another part of the design.

7. **Design from Patterns to Details**. Sort out the big picture first; everything else falls in place after that. Big picture items include factors like climate, terrain and sun aspect. Taking these items into consideration at the very beginning is critical to all of the other decisions that follow, and they ultimately determine the pattern of the design. A permaculture designer uses strategies like sectors and zones (see descriptions below) to help determine the overall pattern. He/she then moves toward specific techniques and plants.

8. **Integrate Rather Than Segregate**. Every element in a system has strengths and weaknesses. In permaculture, we can use this to our advantage by pairing elements with complementary needs, so they help each other grow steadily. For example, in a keyhole garden, the composting system is directly integrated into the garden bed. Placing this keyhole garden close to the kitchen further integrates the system by locating the production area of fresh greens and the receptacle for trimmings and waste near the place where they are used, thus reducing labor.

9. **Use Small and Slow Solutions**. Small and slow changes build resilience and diversity, making our system adaptable and reducing the effect of negative unintended consequences.

10. **Use and Value Diversity**. Diversity forms the foundation of resilience.

11. **Use Edges and Value the Marginal**. The borders or edges between different ecological zones and microclimates are places of great diversity and potential. Species that can thrive on both sides of the edge have an advantage in these zones and can increase the productivity of the entire system.

12. **Creatively Use and Respond to Change**. Things will always change; that's guaranteed. Respond to change by innovating continuously, and don't give up.

IV. Design Strategies

Connecting the ethics and principles of permaculture to a specific site requires a framework of design. Designers use a wide variety of methods to organize their thoughts and articulate their ideas. Some common tools are as follows:

Yeoman's Keyline scale of permanence (Fig. 2) takes into consideration both the time and energy needed to make a change to a specific site or ecosystem. At the top of the scale, at the far end of both the time and effort axes, is "climate"; this aspect would require the most time and energy to change. At the bottom of the scale is "soil."

Sectors (Fig. 3) are used to identify the various factors that interact with a site. Sectors would include phenomena like the path of the sun as it crosses the site; direction of seasonal or predominant winds; human and animal traffic patterns; noise; and visual impacts.

Zones identify the human interaction required to maintain specific areas of a site.

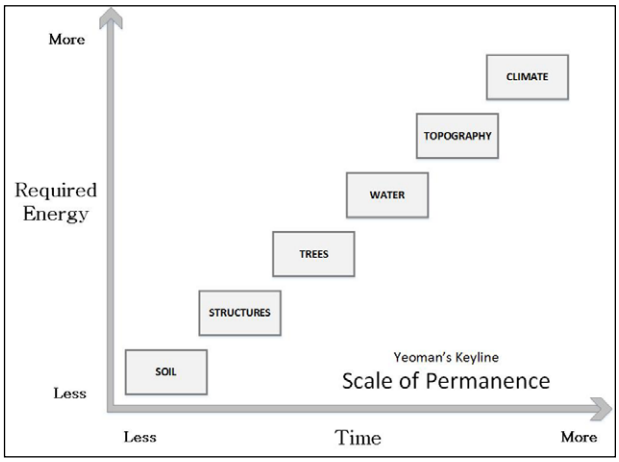


Figure 2: *Yeoman's Keyline Scale of Permanence considers the time and energy needed to make a change to a site or ecosystem. Adapted from Owen Hablutzel's Scale of Permanence graphic.*

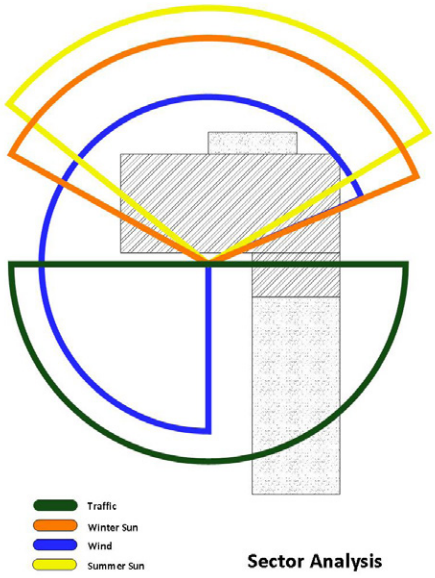


Figure 3: *Sector Analysis helps identify the different elements that interact with a site.*

Typically there are 6 zones, numbered 0 – 5. Zone 0 identifies the home or business structure where people live or work. Zone 1 is the high human traffic area of the site; in a residential setting, zone 1 would be the walkway between the driveway and the front door. It would also include the patio or a nearby kitchen/herb garden. Zone 2 would likely include things like annual vegetable beds and chickens, zone 3 would include fruit trees and pasture, zone 4 would have fuel wood, and zone 5 would be left wild to allow for continued observing and learning from nature.

V. Practices/Techniques

Multi-species integration (plant guilds). Permaculture designers seek to bring multiple stories (canopy levels) of plants together in "plant guilds" to increase and diversify the yield in the system and to add resilience. Agroforestry and forest gardening are exemplary types of plant guilds. An example of a tropical plant guild would be an overstory tree such as a mango combined with shade-loving Barbados cherries, and below them, comfrey and garlic chives.

Agroforestry (multi-story, perennial-based food, fuel and fiber systems).The above example of plant guilding is also a good example of part of an agroforestry system. Agroforestry systems are designed to maximize the usable yields for humans from a multi-storied forest, while maintaining the diversity and increasing the fertility of the forest itself.

Slowing and retaining water. Water is a cornerstone resource in any agriculture system. Good permaculture design keeps ideal levels of moisture in the system with minimal energy inputs. This means channeling away excess water, retaining water in dry seasons, and helping water penetrate the surface to get to the root zone of plants.

Composting. Composting ensures that fertility and nutrients stay inside and are recycled through an ecosystem. From simple compost piles to vermiculture systems to composting latrines, all sources of fertility are valuable and should be stewarded to our best ability.

Natural building. Where possible, use locally available and renewable materials to satisfy the need for shelter. This will help encourage local economies and preserve non-renewable resources. Secure and comfortable homes don't have to look like the suburbs of the West, and imported designs and materials often lead to less comfort and safety. A good example of this is a metal roof replacing palm thatch. The metal roof is often less resistant to hurricane winds; it also transmits heat from the tropical sun, making the house unbearably hot during the day.

Common Criticisms of Permaculture

One common (and sometimes accurate) criticism of permaculture is that proponents make claims about yield potentials or resilience factors with little reliable data to back them up. Because promotion and documentation of permaculture practices is largely decentralized, no official governing body exists to validate the claims of permaculture practitioners and of those who tell permaculture's stories. Lately, there has been robust discussion within the permaculture community about being more careful about what is claimed as fact, and about seeking partnership with people and institutions that can help verify good practice with good science and increase the community's capacity to carry out experimentation that produces usable data and/or leads to more extensive research.

A second, more superficial, criticism of permaculture centers around the lifestyles of people who identity with it. Those caught up in a modern westernized paradigm might be tempted to criticize and marginalize those who have a different outlook, rather than try to understand their point of view—especially if that different outlook challenges some of the practices that make one's life comfortable.

Permaculture in Development

Many permaculturalists subscribe to a post-industrial vision of the future. They see permaculture as a tool to prepare for a less mechanized, less economically globalized and de-urbanized world. As a result, they view the development process differently than typical traditional western development workers would. This view shapes permaculturalists' "better future" paradigm, which impacts their choices regarding prioritization of labor and resources.

As an extreme example, a traditional western development agency working with smallholders in a rural setting might work to create supply and distribution chains that allow the smallholders access to the global market. It might bring non-local and non-renewable resources into the area to increase yields of a single crop or small variety of annual crops. It might envision consolidating smallholder farms into one larger operation to increase efficiency, thereby creating a smaller, more efficient labor force with the hope that those displaced would find better incomes off of the farm. All these efforts would be carried out under the guiding vision that the modernized industrial world is our best vision of the future; that increasing the economic base by creating more consumers has no resource barriers that technology can't overcome; and that hard physical work and traditional rural living are things from which people ought to be freed.

By contrast, a permaculture designer working in the same situation would seek to strengthen the independence of the rural community and protect it from outside influences. He/she would seek to first create an ecosystem and social system that meets basic human needs, and that then trades out of its abundance, with maximum biodiversity. Rather than creating consumers, good permaculture seeks to create more resilient and successful producers who stay on the land, with the knowledge that

their lives are valuable and that their work is among the most intricate and dignified.

My Personal Permaculture Story

My own embrace of permaculture, as both a design tool and a paradigm through which to view good human development, started about 11 years ago. As I embarked on a new career as a "community development/ agriculture missionary," and uprooted my family to a new culture and environment, I began to ask myself a very basic question: "What is development for?"

I was unsatisfied with initial answers that were based on experience. I could see the truly unsustainable nature of so much that was being called sustainable. I could see that the enhanced quality of life promised by the modern world often led to greater depths of misery and despair. I could see that when I said the word "development," I projected a vision of middle class Americana; and I could see that that very lifestyle was crushing the world's ecosystems and was by its very nature unsustainable.

I began to look for a different answer. My reading and research led me to the concept of permaculture. Permaculture provided a new way of thinking about how man could live a productive, abundant life, while nurturing and stewarding creation. I saw that, rather than just laying out a utopian vision, the Permaculture Design Manual and other permaculture literature gave step-by-step instructions for evaluating the natural systems around me and systematically bringing resilience and abundance into those systems. Permaculture design gave me an organized way to look at the big picture, and to plan and test small incremental changes.

Permaculture is good stewardship. For me, it is also a way to work for God's kingdom. I view permaculture's ethical pillars (listed earlier in this article) through different lenses, so that they become the following: 1) actively love God's image bearers; 2) diligently steward God's creation; and 3) live contentedly and joyfully share God's provision.

After practicing permaculture principles on my own for a few years, I took a Permaculture Design Course to increase my proficiency and confidence in using the design processes. The class was challenging and extremely helpful. The exchange of perspective and experience was invaluable, as was having design concepts evaluated by fellow students and a professor. As mentioned earlier, permaculture classes are offered in a variety of formats. The resource section has some links to well-respected courses.

Conclusion

Permaculture is part of the growing community of eco-agriculture disciplines. It is rapidly gaining acceptance as a valuable design methodology in both non-government and government institutions across the globe. It is adaptable to every ecosystem and culture, and offers accessible problem-solving tools rather than silver-bullet solutions. It considers the ecosystem and social system as a whole, facilitating good stewardship, and providing a pathway to true sustainability, resilience and abundance.

Recommended Resources

Books:

Bane, Peter. *The Permaculture Handbook: Garden Farming for Town and Country*. BC, Canada: New Society, 2012.

Beyer, Hunter and Franklin Martin. *Permacopia Book Three: Plants for Permaculture in Hawai'i, & other Tropical & Subtropical bioregions*. Volcano, Hawai'i: Homescapes, 2000.

Falk, Ben. *The Resilient Farm Homestead: An Innovative Permaculture and Whole Systems Design Approach*. Chelsea Green Publishing, 2013.

Fukuoka, Masanobu. O*ne-Straw Revolution: An Introduction to Natural Farming*. NYRB Classics, 2009.

Holmgren, David. *Permaculture: Principles and Pathways Beyond Sustainability.* Hepburn, Vic: Holmgren Design Services, 2002.

Jacke, Dave and Eric Toensmeier. *Edible Forest Gardens, Volume 1: Ecological Vision, Theory for Temperate Climate Permaculture*. Vermont: Chelsea Green Publishing, 2005.

Jacke, Dave and Eric Toensmeier. *Edible Forest Gardens, Volume 2: Ecological Design And Practice For Temperate-Climate Permaculture*. Vermont: Chelsea Green Publishing, 2005.

Lancaster, Brad. *Rainwater Harvesting for Drylands and Beyond, Vol 1: Guiding Principles to Welcome Rain into Your Life and Landscape*, 2nd ed. Arizona: Rainsource Press, 2013.

Lancaster, Brad. *Rainwater Harvesting for Drylands and Beyond, Vol 2: Water-Harvesting Earthworks*. Arizona: Rainsource Press, 2013.

Martin, Franklin. *Plants for Use in Permaculture in the Tropics, 2nd Edition*. Florida: Yankee Permaculture, 2009.

Mollison, Bill. *Permaculture: A Designers' Manual*. Tyalgum, Australia: Tagari Publications, 1988.

Morrow, Rosemary. *Earth User's Guide to Permaculture*. Kangaroo Pr, 1994.

Savory, Allan. *Holistic Management: A New Framework for Decision Making,* 2nd ed. Island Press, 1998.

Toensmeier, Eric. *Perennial Vegetables: From Artichoke to 'Zuiki' Taro, a Gardener's Guide to over 100 Delicious, Easy-to-Grow Edibles*. Chelsea Green Publishing, 2007.

Yeomans, P. A. *Water For Every Farm: Yeomans Keyline Plan,* 4th ed. CreateSpace Independent Publishing Platform, 2008.

Periodicals:

Acres USA – www.acresusa.com

Permaculture Design Magazine – www.permaculturedesignmagazine.com

Internet:

http://permies.com

http://holmgren.com.au/permaculture/

http://www.villageearth.org/

http://permaculturenews.org/

https://www.facebook.com/mpcnetwork.org

http://www.thepermaculturepodcast.com/

Resources quoted in this article:

Ferguson, Rafter Sass. "Wait... you're studying what again? (Part 2): What do you mean by permaculture?" *Liberation Ecology*, November 14, 2012, http://liberationecology.org/2012/11/14/wait-youre-studying-what-again-part-2/

Ferguson, Rafter Sass. "The convenience and poverty of simple definitions" *Liberation Ecology*, June 13, 2013, http://liberationecology.org/2013/06/13/the-convenience-and-poverty-of-simple-definitions/

Ferguson, Rafter Sass. "Continuing the Conversation – Permaculture as a Movement" *Liberation Ecology*, June 25, 2013, http://liberationecology.org/2013/06/25/continuing-the-conversation-permaculture-as-a-movement/

Hemenway, Toby. "What Permaculture Isn't—and Is," November 18, 2012, http://www.patternliteracy.com/668-what-permaculture-isnt-and-is

Inca nut (*Plukenetia volubilis*)

By Dawn Berkelaar and Tim Motis

Inca nut (*Plukenetia volubilis*) is a forest plant from the South American Amazon where it has been used as a wild food source for over 3000 years. It is gaining attention as a valuable vegetable oil crop, and is now being grown more widely. ECHO recently obtained seed from Southeast Asia, which we are growing out in a small planting on our demonstration farm in southwest Florida (Fig 4 and 5). From our limited experience, it seems that Inca nut could easily be grown by small-scale farmers, either for household use or for potential income generation.

Description and uses

Inca nut is also known as sacha inchi, sacha nut, inca inchi, or mountain peanut. This perennial climbing plant is in the Euphorbiaceae family. Flowers appear in clusters, with both male and female flowers on each plant. Pollination results in star-shaped fruits that start out green and turn blackish-brown when ripe.

The heart-shaped leaves are edible when cooked. However, Inca nut is grown mainly for the rich oil (35-60%) and protein (27%) content of the seeds. The protein is highly digestible and rich in essential amino acids. The oil from the seed has a mild flavor and is a rich source of omega fatty acids (Guillén *et al*. 2003). For these reasons, Inca nut has been marketed as a health food supplement. The material that remains after removing the oil from the seeds is used to make flour (also called "protein powder"). The oil and flour are incorporated into various foods and beverages.

Figure 4: *Photo taken in October 2015 of an Inca peanut planting seeded at ECHO in September of 2014. Source: Tim Motis.*

Figure 5: *Photo of green, immature Inca nut fruit. Source: ECHO Asia.*

Health and safety concerns

Although Inca nut has been cultivated for centuries, little was known of its chemical and nutritional characteristics until more recent years. These attributes have now been documented more extensively (Guillén *et al.* 2003; Huaman Saavedra *et al*., 2012; Nascimento *et al.* 2013).

In a study on the safety of Inca nut oil and sunflower oil, biochemical indicators of liver and kidney health were unchanged in adult human subjects who had received a daily amount of 10 to 15 ml (2 to 3 tsp) of Inca nut oil over 4 months (Gonzales and Gonzales 2014). In that study, some participants reported nausea after eating both Inca nut oil and sunflower oil, but this effect declined with time and Inca nut oil was well-accepted after the first week of consumption. We did not find any reports where oil consumption by human subjects was trialed over a long period of time [feel free to let us know if you have more information].

Cultivation

Site selection

Inca nut grows best in warm climates, at low elevations and in acidic soil. However, with sufficient water and drainage, it can grow up to an elevation of 1700 m (5500 ft). With its vertical growth habit (Fig. 4), a lot of seed can be harvested in a small area.

Planting and germination

After clearing weeds/grass from an area, plant the seeds 2 to 3 cm deep at the beginning of the rainy season. Yang *et al* (2014) compared 5 planting densities ranging from 1,666 to 10,000 plants/ha. They found that oil production was highest with 4,444 plants/ha, which can be achieved with plants spaced in a 1.5 m X 1.5 m grid.

In a warm climate, all or nearly all of the seeds should germinate in a few days. Germination reached 93% in a study done in China, with a temperature of 25 to 35 °C (77 to 95 °F) being most favorable for germination (Gong *et al*. 2013). Rosa and Quijada (2013) found that germination was actually better without than with the shell (seed coat), a finding attributed to the slowing of moisture absorption and gas exchange by the seed coat. Figure 6b shows a seed kernel with the outer coat removed. It is also possible to speed up germination by "scarifying" the seed, nicking the outer shell so that the seed can absorb water more quickly after planting.

Figure 6: *Top: dry fruit with seed removed from seed pod. Bottom: Seed with kernal removed from seed coat. Source: Tim Motis.*

Plant growth and maintenance

Weed and water as needed, and supply plenty of fertilizer or compost. In China, seed and oil yields increased (from 1,340 to 2486 kg/ha and from 501 to 899 kg/ha, respectively) as the rate of NPK fertilizer was increased from 0 to 200 kg/ha, showing that Inca nut responds well to fertility inputs (Yang *et al*. 2014). Once established, the well-developed roots can withstand drought but not frost (Gong *et al*. 2013).

An Inca nut plant can reach 3 to 5 m in height or even higher. In the tropics,

and as we have experienced in Florida's subtropical climate, the plants tend to produce long vines. Consequently, it is best to provide support for the vines, such as the trellis shown in Figure 4.

Harvesting and seed use

Plants flower in five months, and seeds are formed by eight months. Once an Inca nut plant begins producing seeds, it can do so almost year-round. A planting in China reached its highest level of fruit production during the second or third year (Gong *et al*. 2013).

To avoid handling the messy pulp in developing fruits, allow them to dry on the plant before harvest. The messy black pulp will dry up.

Raw seeds need to be roasted before eating; otherwise, they are too bitter. Roasting at a low heat (below 60 °C [140 °F]) helps preserve the heat-sensitive omega fatty acids. The oil, on the other hand, is made from raw, unheated seeds. The seeds are "cold-pressed" to avoid damaging (via oxidation) the omega fatty acids in the oil (Cisineros *et al*. 2014). If not used quickly or refrigerated, the oil will become rancid.

Obtaining seed from ECHO

Active development workers registered with ECHOcommunity.org (see the website for how to register) may request a trial packet of seed. We would be very interested to hear of your experience with this little-known crop.

References

Cisineros, F.H., D. Paredes, A. Arana, and L. Cisneros-Zevallos. 2014. "Chemical composition, oxidative stability and antioxidant capacity of oil extracted from roasted seeds of Sacha-inchi (*Plukenetia volubilis* L.)." *Journal of Agriculture and Food Chemistry* 62:5191-5197.

García-Hernández, V.M., M. Gallar, J. Sánchez-Soriano, V. Micol, E. Roche, and E. García-García. 2013. "Effect of omega-3 dietary supplements with different oxidation levels in the lipidic profile of women: a randomized controlled trial." *International Journal of Food Sciences and Nutrition* 64:993-1000.

Gong, D., Y. Zhang, X. Wang, K. Zhang and Q. Liu. 2013. "Experimental study on introduction and cultivation of featured health-care oil plant *Plukenetia volubilis* [Chinese]." *Acta Agriculturae Jiangxi* 25:5-9.

Gonzales, G.F. and C. Gonzales. 2014. "A randomized, double-blind placebo-controlled study on acceptability, safety and efficacy of oral administration of sacha inchi oil (*Plukenetia volubilis*) in adult human subjects." *Food and Chemical Toxicology* 65:168-176.

Guillén, M.D., A. Ruiz. N. Cabo, R. Chrinos, and G. Pacual. 2003. "Characterization of Sacha Inchi (*Plukenetia volubilis* L.) Oil by FTIR Spectroscopy and 1H NMR. Comparison with Linseed Oil." *Journal of Oil and Fat Industries* 80:755-762.

Nascimento, A.K., R.F. Melo-Silveira, N. Dantas-Santos, J.M. Fernandes, S.M. Zucolotto, H.A. Rocha, and K.C. Scortecci. 2013. "Antioxidant and Antiproliferative Activities of Leaf Extracts from *Plukenetia volubilis* Linneo (Euphorbiaceae)." *Evidence-Based Complementary and Alternative Medicine* 2013: Article ID 950272, 10 pages.

Rosa, R. and J. Quijada. 2013. "Germination of Sacha Inchi, *Plukenetia volubilis* L. (Mcbride, 1951) (Malpighiales, Euphorbiaceae) under four different conditions. [Spanish]." *The Biologist (Lima)* 11:9-14.

Yang, C. D.Y. Jiao, Y.J. Geng, C.T. Cai, and Z.Q. Cai. 2014. "Planting density and fertilisation independently affect seed and oil yields in *Plukenetia volubilis* L. plants." *Journal of Horticultural Science and Biotechnology* 89:201-207.

Online information on the properties and uses of Inca nut in Western diets:

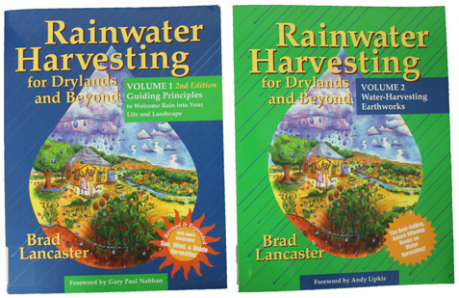
http://www.superfoods-for-superhealth.com/sacha-inchi-oil.html

https://www.youtube.com/watch?v=Jnpo8xwY7FA

BOOKS, WEB SITES AND OTHER RESOURCES

Rainwater Harvesting for Drylands and Beyond by Brad Lancaster

Reviewed by Bob Hargrave



Rainwater Harvesting for Drylands and Beyond is a two-volume set. Volume 1 (2nd Edition) is called Guiding Principles to Welcome Rain into Your Life and Landscape ($29.95 from the ECHO Bookstore). Volume 2 is titled Water-Harvesting Earthworks ($39.95 from the ECHO Bookstore). An accompanying website is found at www.harvestingrainwater.com.

Water flows downhill, which often means away from your yard, garden, field or farm. In these two volumes, written in a personal and engaging style, author Brad Lancaster presents eight principles of rainwater harvesting and describes interventions to slow down or prevent rainwater loss, thus "harvesting" rainwater. The International Water Management Institute claims that "Better management of rainwater, soil moisture, and supplemental irrigation is the key to helping the greatest number of poor people." In these books, Brad has provided perspective, practical plans, and real life examples for helping better manage rainwater for crop production.

In Volume 1, Brad helps you discover your farm's rainfall patterns, amounts and flow. He then guides you in planning how to harvest and use the rain that falls on your land.

In Volume 2, Brad describes many types of earthworks designed to harvest rainwater, providing examples from around the world. With each system he also provides step-by-step instructions for constructing earthworks such as berms, terraces, swales, basins and more.

If you live and work where water is the limiting factor for agriculture, the two volumes of *Rainwater Harvesting for Drylands and Beyond* will be valuable additions to your library.

A new conservation agriculture newsletter

In September we received by e-mail an issue of the Conservation Agriculture Newsletter. It is sent out by Putso Nyathi and Neil Miller, who work as Technical Officers with Canadian Foodgrains Bank. The CA Newsletter is filled with practical information based on field work that is going on in East Africa. September's was Issue 2; it featured titles including "Extension Approaches in Promotion of Agricultural Innovation" (with discussion on farmer field schools and farmer-to-farmer extension) and "Green Manure/Cover Crops" (with helpful insights on legume selection for intercropping with short- versus long-term crops). If you would like to receive the newsletter, sign up at https://vr2.verticalresponse.com/s/canews-letter.

SAWBO (Scientific Animations Without Borders)

Short video animations in multiple languages are available through Scientific Animations Without Borders (SAWBO), a program administered through the University of Illinois at Urbana-Champaign. The videos cover a broad range of technical agricultural topics, and can be downloaded free of charge to those using them for education/training. Animations can be viewed using various devices including computers, cell phones, and overhead projectors.

On the home page (http://sawbo-illinois4.org/), click on "Video Library" to access English animations on topics related to agriculture, health, and women's empowerment. A few of the topics under agriculture include making natural insecticide from neem; using salt to test for grain moisture levels; solar treating cowpea seeds, creating compost, and using drip irrigation. Many of the SAWBO animations are available in multiple languages through SAWBO's Video Library. These videos could be integrated into extension efforts on behalf of small-scale farmers. As stated on their home page, SAWBO has its own YouTube channel and asks that animations NOT be re-posted on YouTube.

UPCOMING EVENTS

International Events:

Best Practices in Areas of Conflict

November 3-6, 2015
Christus Center - Arua, Uganda

Presented By: ECHO East Africa

First International Symposium on Moringa

November 15-18, 2015
Philippines

Presented By: International Society for Horticultural Science

Central America/Caribbean Regional Conference

September 27-30, 2016
Managua, Nicaragua

Save the dates! Information will be posted soon to the event page on ECHOcommunity.org

ECHO Florida Events:

22nd Annual ECHO International Agriculture Conference

November 17-19, 2015
Crowne Plaza Hotel and ECHO Global Farm, Fort Myers, Florida

TAD I: The Basics

January 18-22, 2016

Our introductory Tropical Agricultural Development course for those interested in preparing for short/long-term involvement in agricultural development internationally.

Agroforestry/Perennial Cropping Workshop

Second week in April, 2016; final dates to come.

This workshop will include field-based surveys of perennial crops and various agroforestry systems based on the ECHO campus and at nearby farms, practicums on food forest establishment and maintenance, and an overview and detailed discussions of global agroforesty and perennial cropping systems

Presented by: Eric Toensmeier and ECHO staff.

Permaculture Design Certification Course

April 20-30, 2016

Missional Permaculture Network and ECHO are teaming up to bring a permaculture design certification course with a focus on international development. The 11 day course will include guest instructors with deep experience in both development and permaculture design practice.

More information will be posted soon to the event page on ECHOcommunity.org.

PLEASE NOTE: At ECHO we are always striving to be more effective. Do you have ideas that could help others, or have you experimented with an idea you read about in *EDN*? What did or did not work for you? Please let us know the results!