ECOLOGY ACTION'S
GARDEN COMPANION

GROW BIOINTENSIVE® News from Around the World

image: shannon joyner

SUMMER 2023

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The Jeavons Center Mini-Farm Report

By John Jeavons, Ecology Action Executive Director

At The Jeavons Center (TJC, Ecology Action's GROW BIOINTENSIVE® Closed-Loop Sustainable Mini-Farming world headquarters), things have been busy as always! Heading into summer, we continue to grow fertile soil in an area of difficult serpentine soil rated "fair for grazing" by the NRCS.

In fact, our FTT team has been able to grow a stable climax ecosystem using GROW BIOINTENSIVE (GB) in just 37 years, using *annual crops*, confirmed by independent soil tests which show the amount of organic matter in our mini-farm soil to be equivalent to that which would take an uncultivated ecosystem hundreds of years to achieve. A climax ecosystem is one in which ecological succession has taken place, changing the mix of species and habitat and soil composition in an area over time, with the less stable communities gradually replaced until a stable, mature community is reached – like an established forest where a mix of scrub used to be, or in this case, a flourishing garden where thin, nutrient-poor grass once struggled to grow. The thing is, climax ecosystems normally develop with perennial plants, and the process takes hundreds of years. Years ago, at a meeting with representatives from TJC, Victory Gardens for Peace, and the Golden Rule Community, one of our former FTTs, Rachel Britten, asked an inspired question: "*I wonder if a climax ecosystem can be grown with annuals using GROW BIOINTENSIVE?*" ...and it turns out that the answer is "Yes!" as you can see from the following pictures. And the work is ongoing: now in our 52nd year on our hillside outside Willits, CA, we're continuing to nurture our mini-farm ecosystem by testing the strengths and less desirable aspects of using four different types of compost on Growing Bed 21. What began as a test to determine the nature and usefulness of different carbon:nitrogen ratios in compost, the results of this study may be used to show people how to hold more water and nutrients in the soil – an important piece of information for the five billion people, or around two-thirds of the world's population, who will face severe water shortages by the year 2050.

The Jeavons Center, January 1982

August 1982: 2 people working 14h/week x 11 weeks

More details about this and many other interesting facts about GB and our research are in my latest book *The Next Steps*, which I hope to have published by the end of the year, including what types of alfalfa will grow best, and the advantages and challenges gardeners should be aware of as the plant brings up nutrients from deep in the soil; why Grizzly Dormant Alfalfa is the best; and how Banner Cold-Weather Fava Beans are most productive. (Note: sadly, both Grizzly and Banner seeds are rare, and difficult to find on the internet. You can do something about this if you can manage to find some of these seeds and grow them out to save, use, and share. Why not become a Living Seed Bank in your region?)

On June 3, TJC's Farmer/Teacher Trainer Team (Manager Melvin Castrillo specializing in overview, and FTT/Assistant Manager Suraya David Sadira specializing in compost and herbs, and FTT Jessi Mickow, specializing in soil preparation) gave a tour of our site to a delightful group of interesting and motivated people from diverse locations – one each from the California communities of Laytonville, Fort Bragg, Davis, Sebastopol, and Fremont, and one from Gardenville, Nevada. A wonderful couple from Japan attended as well, interested in

August 1983

increasing Japan's farmable soil from 1,246 sq.ft. per person to 70,000 square feet, the area it takes to grow the mainly imported Japanese diet. They told us many young people in Japan are interested in embracing an organic and sustainable way of farming. They inspired us! Tour topics included: the philosophy of GB and its Eight Essential Elements, growing bed soil preparation, composting, an herbal tour, and discussion of interesting facts like number of calories one gallon of water can produce (see p. 99 in *How to Grow More Vegetables*), and the optimal conditions for raising healthy seedlings — with many information sheets given out from Ecology Action's extensive publication list. Books, booklets, and DVDs were made available as well. On June 6, we enjoyed a visitor from Paris, France, who had previously taken a 4-Saturdays Online Workshop and had been inspired to pre-arrange a visit to see our work in person.

It can't be denied that our world is facing a lot of challenges, and that we've got our work cut out to build a sustainable and abundant future. But as the cool mist of spring recedes and the warm, dry days

July 1984

of a Northern California summer begin, looking out at the vigorous, joyously ALIVE mini-farm, growing sustainably, year after year, in soil that wasn't supposed to be able to support it, I feel like a good overall theme for approaching life might be seen in Raymond Williams' reflection from *Resources of Hope* (1989, p. 118): "*To be truly radical is to make hope possible, rather than despair convincing*." Sounds good! Let's be truly radical together, wherever we

July 1995: 14 years of GB cultivation, new soil fertility plateau achieved

are!

Our next 4-Saturdays Workshop taught by John Jeavons and Matt Drewno will be held online Oct. 28, Nov. 4,11 & 18, 2023 (growbiointensive.org/events_main.html for more information). I hope to see your smiling faces there. Happy Gardening, and Happy Summer to our global GROW BIOINTENSIVE Family from the Ecology Action team! •

Microscaling Agriculture with GB: A Key to Peace and Sustainability

By Matt Drewno, VGFP Mini-Farm Manager

Below are 10 reasons why choosing to micro-scale with GROW BIOINTENSIVE (GB) instead of using conventional agriculture is an important part of growing solutions to world challenges:

1. GB conserves and restores more land: Conventional agriculture drives deforestation and is responsible for over 85% of threatened or endangered species.[1] As a result, scientists state that we may lose 30-50% of all species by 2050.[2] Our ecosystems are valuable because they serve as repositories for life and regulate our climate. GB can microscale agriculture by 50% (and up to 98% with a developed skill level and good diet design). This allows more resources to be conserved and ecosystems to heal.

2. GB builds topsoil faster: There is an old saying: "*For all of man's technological advances, he still relies on the top 6 inches of topsoil and the chance it may rain.*" It can take nature from 3,000-12,000 years to develop that 6 inches of topsoil. Our current agricultural methods are destroying topsoil at a rate of 30,000,000 acres per year according to the UN,[3] which is 10-40 times faster than it is replenished naturally.[4] With GB one can build soil 60 times faster than nature.[5]

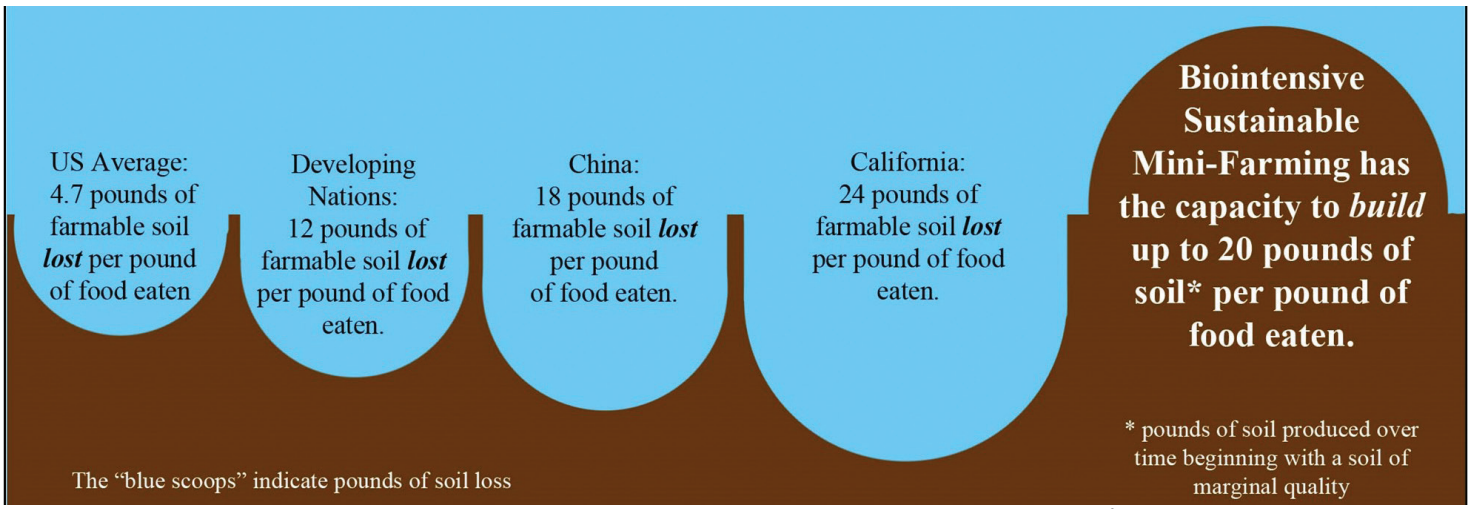
3. GB conserves water: Agriculture uses roughly 80-90% of freshwater in the United States.[6] Currently, the UN states that 1/3 of the world's population is living under water stress and by 2025 almost half of the world's population will be living under high water stress.[7] Compared to conventional methods, GB requires only 33% of the water per pound of grain and 12% per pound of vegetable produced.[8] A 1,000 sq ft GB diet design requires as little as 2-10% of the water to grow a nutritionally complete vegan diet compared to a conventionally grown standard American diet.

Comparing the Water Use Footprint of Different Diets for an Average Growing Location

Diet/ Water Use	Gallons/ Day	Gallons/ Year	Efficiency Index
Avg. American (Worldwatch)[9]	4,200	1,533,000	1x
Avg. American (Nat.Geo.)[10]	1,000	365,000	4.2x
Vegan (Worldwatch)[11]	300	109,500	14x
GB 10-Bed Unit (1,000 sq ft)	125	45,625	33.6x

4. GB increases yields sustainably: With a basic level of skill, GB can increase yields 2-4x those of conventionally produced food.[8] In cucumber trials, Ecology Action achieved over *10 times* the expected conventional yields.[11] The whole-systems GB approach helps farmers and gardeners increase yields sustainably while building soil and conserving water, energy and fertilizer.

5. GB reduces fertilizer inputs: The GB method attempts to "close the loop" on fertility by reducing the need for imported fertilizers. This is accomplished by growing compost crops (including legume cover crops), and using special composting techniques and crop rotations. A published study in Kenya demonstrated the potential for farmers to increase yields with a significantly reduced amount of fertilizer input using GB.[12]



An important component to completely closing the fertility loop is the proper, legal, and safe recycling of human waste. Currently, work is being done to develop safe methods on a societal scale. For thousands of years many cultures recycled humanure back into their agricultural systems; ***however***, *it is critical to do this safely, legally, and properly* or it will spread disease. For more on this subject, I highly recommend John Beeby's book *Future Fertility* (Ecology Action, 1995).

6. GB is accessible, appropriate, and empowering: The method helps vulnerable communities around the world establish models for food security and resource conservation. GB is highly adaptable and perfectly suited for urban environments where over 55% of the global population resides.[13] GB does not require large acreage or heavy machinery or tractors to produce. Because GB intensifies and microscales agriculture, it is easier to harvest and store sufficient rainwater to grow food, which prevents salinization of soils and enhances the growing season. GB is particularly efficient at a the scale of home and community gardening. An analysis of over 22 studies concluded that gardening reduces depression, anxiety and body mass index while increasing life satisfaction, quality of life and sense of community.[14] Our gardens are oases of hope.

7. GB uses less energy: Published studies demonstrate that mechanized fossil fuel-powered agriculture requires 7 to 13 calories of energy to produce 1 calorie of food.[15,16] The GB system can produce up to 40-47 times more energy-calories than is used to grow our food.[17] With the GB method we can grow our way out of fossil fuel addiction, combat climate change, and create a better future where there is *enough for everyone, including nature.*

8. GB is more resilient to climate change: The GB approach is highly adaptable and scalable. It enables people to grow more food with less water, making farms and gardens more successful in times of drought. GB helps individuals learn to empower themselves, downscale consumption, and transition to local food production without destroying our environment. This helps communities stabilize during times of climate change. See Ecology Action's publication "*Climate Change and GROW BIOINTENSIVE*" (Beeby, 2016).

9. GB takes less time, money, and effort to grow food compared to other approaches: The increased efficiency and reduced space required with GB means you don't have to purchase several acres or be a full-time farmer to provide food for your family. After a little practice, you can grow a complete and sustainable diet for yourself in around 1,000-2,000 sq ft. Time trials at Victory Gardens for Peace in Mendocino, CA, demonstrate an average of 35 minutes per day are required to grow a complete and sustainable diet. Why not grow a productive, beautiful and sustainable garden?

10. GB increases the possibility for peace and prosperity for all: Most conflicts and wars are fought over resources. Our current polluting and wasteful agricultural models feed consumerism instead of healthy people. Around one third of what is grown on large farms is wasted, often not even composted to maintain the soil. Localization through home-and-community scale GB food production enables communities to become more independent, resilient, and likely to thrive as we transition away from non-renewable resources and extraction-based consumer economies.

"You enter the garden because you love creation. You just want to grow fruits, vegetables, and flowers as an expression of your soul. You love the smell of soil, the mystery of life, culture, and all the exquisite things that God gives us to live upon, look at, listen to, and enjoy.

Great enchantment and productivity grow with each year of the garden. True vision, the necessary permit for this growth, expresses the enormous possibility of what can be achieved. Imagination is required right from the start. The era in which we live is a little frightening when you look at it very plainly and don't endeavor to escape the truth of what we are doing to the world. The vision of which I am talking is one of the greatest things we can possibly conceive of. It is a recovery from all the destruction going on. It is possible."

-Alan Chadwick

Footnotes for this article are available online at growbiointensive.org/Enewsletter/Summer2023/vgfp.html ●

VGFP 2023 International Interns

My name is Clarice Wawuda Mwakudu, a Kenyan citizen aged 28 yrs from Taita-Taveta County, which is in the coastal region of Kenya. I am currently an 8-month Intern at Victory Gardens for Peace. I started farming when I was young, since my parents are farmers. We grow crops like maize [corn], cowpeas, and green grams [mung beans], and keep small livestock like goats and chickens. Our farm borders both Tsavo East and West National Park, so we face a challenge of wild animals invading in our farm and destroying our crops.

I went to a school near my village for both primary and secondary education, and after high school I joined Manor House Agricultural Centre (manorhouse.or.ke) in Kitale Kenya, where I graduated with a diploma in Biointensive Agriculture in 2017. My main aim was to learn more about farming so as to share what I learned with my community, where they had no knowledge of growing different types of crops, or seed-saving and its importance. Before graduation I first did my three-month industrial internship with Garden of Hope (GOH), a community-based organization in Taita-Taveta County, Voi Sub-County [established by EA 2016 intern Mlesh Mlegwa]. After my internship was finished, I worked as a volunteer with Garden of Hope and later secured employment to work with the same organization and I was the pioneer. Like my family's farm, Garden of Hope boarders Tsavo East and West National Park so they also encounter a lot of challenges from their crops being destroyed by wild animals. Kenya is experiencing a long-term drought, but GOH, operating in the driest region of Taita-Taveta County, managed to maintain an evergreen zone throughout the year, through the use of GB farming methods and training of farmers in the community to do the same. In addition to GB training and demonstration, GOH advocates caring for the environment by growing trees, and we supply trees seedlings to the community. During my 8-month Internship with Ecology Action this year, I would like to learn how to be a sustainable farmer, and to grow a healthy soil, which leads to production of a healthy food, and thus a healthy nation. Over the last past two months I have spent at Victory Gardens for Peace, it has come to my realization that LIFE STARTS FROM THE SOIL. What that means is: if I want to grow my food, I must prepare my garden well through deep soil preparation; and if I want to grow healthy crops, I must feed my soil by addition of compost and other organic amendments like alfalfa meal; and when watering, I water the soil and not the plants; and also, in case of disease infestation of crops, it's my soil which is sick, and not the crops. This knowledge of GROW BIOINTENSIVE has opened my eyes, and after my internship I look forward returning to Kenya and sharing what I have learned with my community: how to take care of the soil so the soil can feed you. My main aim when I return is to have a demonstration site where I will train farmers to use GB, and show them how it's important to take care of the soil and because it's the holder of life. My goal is to train my community to grow healthy and clean food as we build the soil and conserve the environment.

My name is Eliakim Kipngetich, and I come from a town known as Eldoret, in the Rift Valley, Uasin Gishu County, Kenya, where I have been working with an organization called Agroecology Advocacy for Change Foundation (ACF). Our mission is to unlock the potential of nature and improve the quality of life through agroeological practices and restoration of wholeness. Our vision is to inspire and empower communities living in harmony with nature, through farmer training, organic value chain establishment, working with rural communities to promote access to clean food through agroecological practices, and environmental protection.

Agriculture has been a passion and a career, as well as a way of life to me. I have been doing agriculture from my childhood till now, growing corn, sugarcane, and tea on my father's farm. This is why I had to follow my passion even after getting a degree in

Tourism Management. I have worked hard in community mobilization and capacity-building in sustainable agriculture, motivating and encouraging team members to develop more organic markets and learning centers for farmers and youth.

Currently, I am in California, at Victory Gardens for Peace completing my 8-Month Internship with Ecology Action. I have learned many things from John Jeavons' classes, from Matt Drewno the manager of VGFP, staff members Janét, and Matthew, and from Clarice, who is another intern from Kenya.

During my time with Ecology Action, I have learned that we should take good care of our soil, to have the right tools for farming, and to use the 8 principles of GROW BIOINTENSIVE: double digging, using compost to achieve sustainable soil fertility with organic matter and nutrients, close spacing, companion planting, complete diet mini farming (calories and carbon), open pollinated seeds, and working with a whole system. I particularly liked the part about compost: where it's important to return nutrients into the soil after plants have taken them out of the soil. The crops I like to grow most are wheat, fava beans, and oats because I will get enough biomass for my compost, and nitrogen fixation in the soil. Compost always assists in improvement of soil structure, aeration, and water retention.

After my 8-month internship I will go home and start my own farm, which I will run with my sister, who has also been working with agricultural organizations. I will also share what I have learned with others, teaching them that GROW BIOINTENSIVE:
[a] provides cheap method of food production;
[b] is easy to implement;
[c] uses of less water; and
[d] offers a cheap way to fertilize. ●

Dahlia Project Update

By Suraya David-Sadira
FTT and Assistant Mini-Farm Manager, TJC

In 2021, we established an experimental 10-Bed Unit at The Jeavons Center with a diet design including dahlias as a versatile carbon/calorie/income crop. This is part five a continuing series on this project.

Since the last update, we have gotten all the tubers in the ground and they have almost all sprouted. This year, instead of doing 25-50 square feet each of 4-5 varieties, we chose to do 10-20 square feet of 15 varieties, so we can observe how more varieties do at our site, and adequately choose which ones we want to expand on next year. We planted 250 square feet of dahlias which came out to 98 tubers planted on 18-inch offset centers, out of which 92 sprouted successfully. The tubers planted this year are second-generation TJC, coming from last year's divided and stored tubers. That feels like a pretty good dividing and storing success to me!

We planted Thomas Edison, Maki, Patches, Mikayla Miranda, Hometown Hero, Who Me?, Citron du Cap, My Hero, Giggles, Chick-a-Dee, and a couple of unknown varieties that I named Lady Love, Orcas 1, Orcas 2, Orcas 3, and Little Amanita. So far the Thomas Edison, Maki, Patches, Mikayla Miranda, and Hometown Hero, seem to be the most promising, but I look forward to observing how the other 10 varieties do. Most of the dahlias are about 8-12" tall and most aren't flowering yet, but this is right on track since they are a late summer to early fall bloomer. This summer we'll be observing how many flowers we get, what size and color, and will be weighing the tubers when they go into storage this winter. I look forward to seeing all these beautiful flowers and will keep you all updated as well.

If you are interested in keeping data on your favorite dahlia variety and want to share your findings with us, please reach out to Surayasadira.ecologyaction@gmail.com and I will send you a data sheet and instructions on how to follow our data gathering guidelines. ●

Recipe: Smashed Cucumber Salad (Vegan, Gluten Free)

By Shannon Joyner, Garden Companion Editor

This year we had an old-fashioned Northern California winter: cold, wet, and continuing well into June. Now with August on the horizon, the temperatures have climbed over 100°F, summer is truly here, and I'm done with the oven for the season. When it's really hot, I want something cool, light, and refreshing, and this Asian smashed cucumber salad is my new favorite. Inspired by the recipe at thewoksoflife.com/smashed-asian-cucumber-salad it's tangy, spicy and savory, great on its own or served alongside your favorite grilled protein, in a Buddha bowl with spicy rice noodles (recipe in the *Garden Companion* Summer 2022 issue), or as a topping for bánh mì sandwiches. Chinese Traditional Medicine considers that cucumbers are good for cooling excess heat in the body (and science has shown that cucumbers' internal temperature in the field can actually be up to 20°F cooler than the surrounding air); they're 95% water, so eating them helps keep you hydrated; and they're a good source of vitamin K which is essential to bone health. Smashing the cucumbers is a traditional Chinese technique to crack the skin, open up the seeds, and give a pleasantly rough texture to the cucumber, allowing it to soak up the dressing. If you're feeling the heat and are wondering what to make for dinner, give this cool and satisfying salad a try!

Ingredients (~4 servings)

2 cucumbers (preferably seedless Persian or English, about 1-1.5 lbs/ ~ 600g)
1 bunch of cilantro with stems
1 carrot (optional)
1/4 teaspoon salt, to taste
2 teaspoons sugar, to taste
2 T toasted sesame oil
4 T gluten-free tamari
2 T rice vinegar
2-4 cloves garlic (finely chopped)
1-2 teaspoons chili crisp (I like Fly By Jing brand which has crunchy Sichuan peppercorn bits)
2 teaspoons seaweed gomasio (a Japanese condiment made of sesame seeds, seaweed and salt)

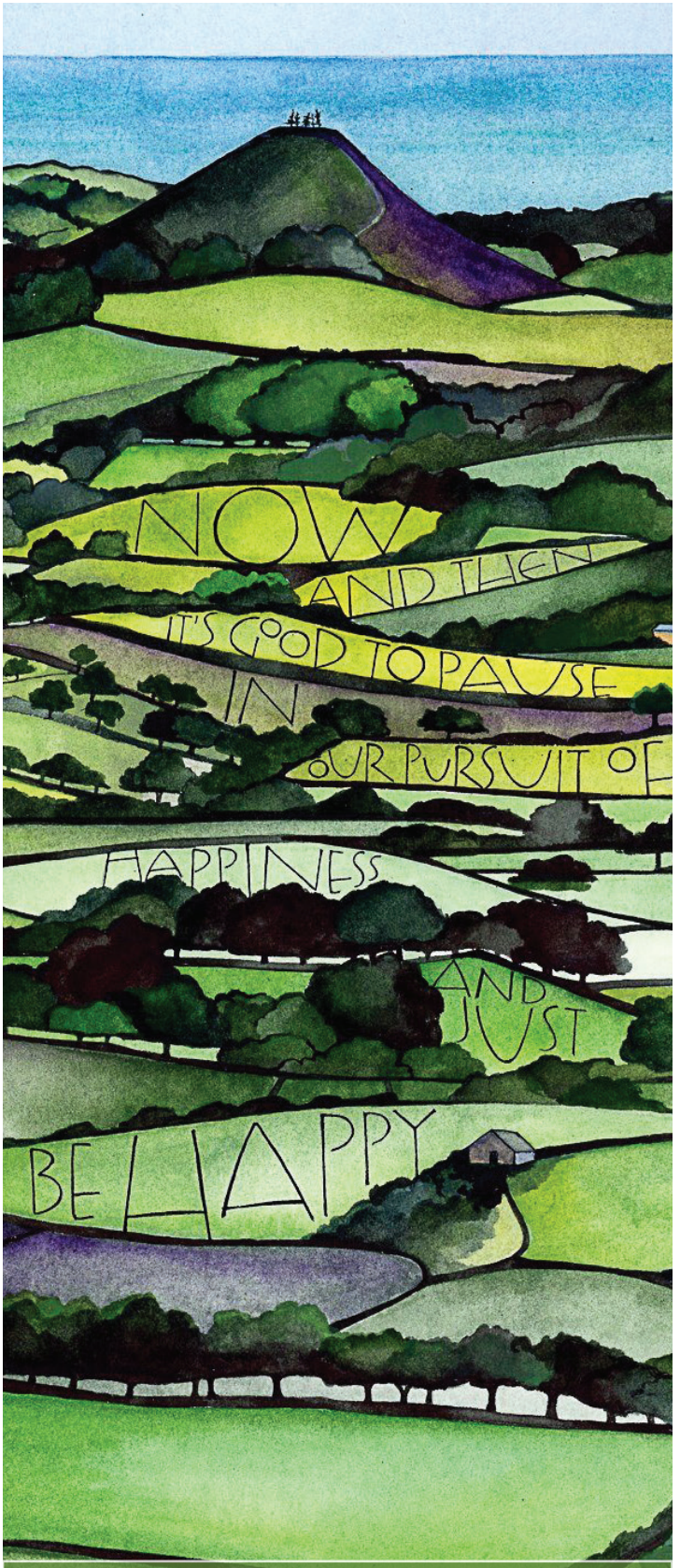
In a small bowl, make the dressing for the salad by whisking together the salt, sugar, oil, tamari, vinegar, garlic, chili crisp, and gomasio until the salt and sugar are dissolved. Taste and adjust seasoning. Set aside.

Wash and dry the cucumbers, cilantro, and carrot. Coarsely chop the cilantro, and julienne the carrot into thin matchsticks. (If cilantro tastes like soap to you, use parsley or arugula. Chopped basil and mint are also a nice addition.)

On a cutting board, lay a large knife flat against the cucumber, and press the blade down gently with your hand (be careful not to cut yourself! You can also use a saucepan or a wide spatula to do this if you're not comfortable using a knife). The cucumber should crack open and smash into four sections. Repeat along its full length. Once the whole cucumber is completely open, remove the seeds if using a seeded variety, and cut the sections at a 45-degree angle into bite-sized pieces and place them in a serving bowl.

Add the chopped cilantro, carrot matchsticks, and a generous amount of the prepared dressing, toss gently to combine, and serve immediately, with any leftover dressing on the side—it's good on everything! (Note: this salad is best eaten the day you make it. If you want it to travel, keep it cold, and don't dress it until you're ready to serve or it'll lose some of its crunch.) ●

image: shannon joyner



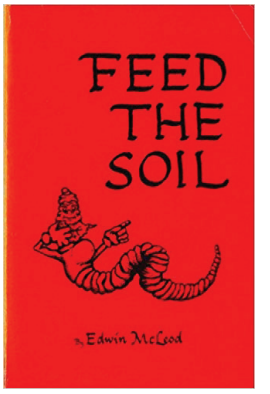
Artist: Sam Cannon
https://samcannonart.co.uk
Quote: Guillaume Apollinaire

Book Review: Feed the Soil

By John Jeavons, Ecology Action Executive Director

Kenya is in an ongoing drought, causing food prices to skyrocket; 20% of Spain is desertified, and 75% is considered dry or semi-arid and at high risk for desertification (www.aa.com.tr/en/europe/soil-to-sand-spain-s-growing-threat-of-desertification/1535951); it was so hot in Athens (118°F) this summer that they closed to Acropolis to protect tourists; massive Canadian wildfires turned the sky in New York City orange with smoke. Things are abnormally dry, and getting drier. It is understood that the Earth is becoming increasingly desertified and water is scarce in many places. One of the ways we can help slow desertification and reduce water use in agriculture is to improve the soil, and an important part of improving the soil is increasing nitrogen levels so healthy plants can grow.

In his excellent and comprehensive book, *Feed the Soil*, (Organic Agriculture Research Institute, 1982—don't let the date put you off, the information is still completely valid today), Edwin McLeod teaches you how to improve soil fertility through natural methods, and describes a number of crops, including legumes, that can do reasonably well in droughty areas, fixing nitrogen the the soil through a symbiotic relationship with soil microbes. The book advocates the "green manure" method of tilling the plants under after they mature to build soil, but with GROW BIOINTENSIVE, these legumes are rendered even more efficient, because they are cut when they begin to flower, so the nitrogen fixed in the root nodules is kept in the soil, and not used by the plant to create seeds, and the biomass of the cuttings can be used to make compost.



Some excellent nitrogen-fixing varieties for limited water situations are listed in the book by climate category: Many Climates, Cool Climate, Cool and Dry Climate, Hot Climate, and Hot and Dry Climate. I found the Jack Bean (*Canavalia ensivorma*) pp.113-114 and the Moth Bean (*Phaseolus aconitifolius*) pp. 146-147 of particular interest, and the detailed descriptions of all the crops are comprehensive and help the reader gain a good understanding of the nature of each crop and conditions under which they grow. Good reading for gardening on a hot planet! •

Soil Science Spotlight: The Dr. John Doran/ USDA Soil Quality Test Kit Guide, Part 2

By John Beeby (growyoursoil.org)
Ecology Action Soil Fertility Advisor

Soil testing and the correct use of organic amendments is an important part of GB. John Beeby and Ecology Action created the "Soil Science Spotlight" to introduce the topic to the GB community. Read the whole series at growbiointensive.org in the "Protocols" section.

In Part 1 of this series, I introduced the USDA *Soil Quality Test Kit Guide*, developed by Dr. John Doran (bit.ly/DoranSoilTest). I do not plan to restate all the excellent information in the *Guide*. Instead, I mean to expand on the information you can derive from these simple tests. For years, I knew about Dr. Doran's *Guide*, but somehow did not realize its potential until recently. It has become clear to me that the *Guide* provides farmers who lack access to soil laboratory analysis, with the ability to better understand a soil and to determine ways to improve its fertility. Even for those who have access to a soil lab, the tests in this *Guide* can provide additional information on your soil that lab analysis cannot. As our world continues to lose soil fertility at an increasing rate, and with the majority of farmers in the world lacking access to soil testing services, developing the ability to assess a soil and know how to improve it is increasingly important. The *Guide*, in combination with an approach like *Test Your Soil with Plants* (my book, which describes how observing plants in your garden can help you determine what fertilizers to use to optimize your garden's health and productivity), can allow an observant and thoughtful farmer to understand their soil, and improve its health and fertility, even if they cannot afford a soil laboratory test and professional amendment recommendation.

The *Guide* describes tests for: **infiltration, bulk density, soil respiration, electrical conductivity, pH, nitrate, aggregate stability, slaking, earthworms, physical observations, and water quality**. I'll be discussing the first two in this segment. These tests can be used in two ways:

- First, they can be used to compare two different soils. For example, perhaps one soil produces lower yields compared with another soil, and you want to understand why. Or you want to compare differences in a soil when using two different growing methods—say, GROW BIOINTENSIVE and Biodynamic farming. Or to determine what changes occur in a soil when growing more deep-rooted compost crops. These types of comparisons are ideal for the *Soil Quality Test Kit Guide*.
- Second, the test results can be used to generate a numeric value, which you can interpret using the *Guide's* reference tables, allowing you to see where your soil stands in relationship to other agricultural soils, and how to improve it. For example, using a pH strip with a range close to agricultural soils, you can determine the approximate pH of your soil. Then, using the *Guide's* reference chart, you can see if your soil is a little too acidic or alkaline. Another example is bulk density (g/cm^3), which is a very useful quantitative soil measurement. Looking up your soil's bulk density and soil texture (which you can determine yourself) in a chart can help you determine if the soil is compact enough to affect root growth and may need cultivation, or if it is loose enough that you can skip tilling the soil to conserve more organic matter.

The **Infiltration** test is very simple, but useful. With this test, we are measuring how quickly water can enter the soil. Simple enough! But from this, we can also get an idea of how good the soil's structure is, how prone it is to water erosion, and indirectly, its level of organic matter, which is critical for so many soil functions.

The **Soil Bulk Density** test is another measurement you can make yourself to get a sense of how much organic matter is in the soil. The more organic matter a soil contains, the lower the bulk density, because organic matter improves a soil structure and increases the air space in a soil, and therefore decreases the soil's weight/cm^3. By knowing the soil's texture (a characteristic you can determine yourself, not described in the *Guide* but easy to find online, for example, using the USDA Soil Texture Calculator www.nrcs.usda.gov/resources/education-and-teaching-materials/soil-texture-calculator), you can determine if the soil's bulk density will negatively affect root growth due to excessive soil compaction. If you determine that your soil has a dense texture, you know that it makes sense to loosen your soil, and if you find the soil's bulk density will not prevent root growth, then you can be assured that tillage is not needed, allowing you to conserve your soil's organic matter this season. ●

Grow YOUR SOIL

Soil Science Spotlight

If we understand a soil, we can improve it

The Guardian: Improving soil could keep world within 1.5C heating target

The following is an excerpt of an article published in The Guardian *in July 2023 which you can read in its entirety at https://www.theguardian.com/environment/2023/jul/04/improving-farming-soil-carbon-store-global-heating-target. In terms of climate change mitigation, one of the primary benefits GROW BIOINTENSIVE offers is the ability for small-scale farmers to rapidly sequester large amounts of carbon in the soil—exactly what is discussed in this article. Imagine if small-scale farmers (who make up the majority of farmers worldwide) could get paid carbon credits for using GB to restore degraded farmland!*

Marginal improvements to agricultural soils around the world would store enough carbon to keep the world within 1.5C of global heating, new research suggests.

Farming techniques that improve long-term fertility and yields can also help to store more carbon in soils but are often ignored in favour of intensive techniques using large amounts of artificial fertiliser, much of it wasted, that can increase greenhouse gas emissions.

Using better farming techniques to store 1% more carbon in about half of the world's agricultural soils would be enough to absorb about 31 gigatonnes of carbon dioxide a year, according to new data. That amount is not far off the 32 gigatonnes gap between current planned emissions reduction globally per year and the amount of carbon that must be cut by 2030 to stay within 1.5C.

The estimates were carried out by Jacqueline McGlade, the former chief scientist at the UN environment programme and former executive director of the European Environment Agency. She found that storing more carbon in the top 30cm of agricultural soils would be feasible in many regions where soils are currently degraded.

McGlade now leads a commercial organisation that sells soil data to farmers. Downforce Technologies uses publicly available global data, satellite images and lidar to assess in detail how much carbon is stored in soils, which can now be done down to the level of individual fields.

"Outside the farming sector, people do not understand how important soils are to the climate," said McGlade. "Changing farming could make soils carbon negative, making them absorb carbon, and reducing the cost of farming."

She said farmers could face a short-term cost while they changed their methods, away from the overuse of artificial fertiliser, but after a transition period of two to three years their yields would improve and their soils would be much healthier.

She estimated it would cost about $1m (£790,000) to restore 40,000 hectares (99,000 acres) of what is currently badly degraded farmland in Kenya, an area that is home to about 300,000 people.

Downforce data could also allow farmers to sell carbon credits based on how much additional carbon dioxide their fields are absorbing. Soil has long been known to be one of Earth's biggest stores of carbon, but until now it has not been possible to examine in detail how much carbon soils in particular areas are locking up and how much they are emitting. About 40% of the world's farmland is now degraded, according to UN estimates.

Carbon dioxide removal, the name given to a suite of technologies and techniques that increase the uptake of carbon dioxide from the air and sequester the carbon in some form, is an increasing area of interest, as the world slips closer to the critical threshold of 1.5C of global heating above pre-industrial levels...●

Widespread use of GB could dramatically reduce agricultural carbon dioxide emission rates. Read more in our free ebooklet Climate Change and GROW BIOINTENSIVE, *available in English, Spanish, and French at https://bit.ly/ClimateChangeGB.*

Bioirrigation and Its Use in Biointensive Production

By Steve Moore

Bioirrigation, also called hydraulic redistribution or hydraulic lift, is the process where soil water is translocated by plant roots from wet soil, through root xylem vascular pathways, to dry soil areas. This process is driven by a water potential gradient. In short, bioirrigation moves water through roots from high soil-water concentrations to low soil-water concentrations. This makes water more uniformly available and for longer periods of time, especially in intercropped plants with diverse root architectures"

With Bioirrigation, the root vascular system becomes the irrigation pipes that can move water in a variety of ways. The deep roots can move water from 1) deep wet soil to shallow dry soil or 2) from wet shallow soil to dry deep soil. Roots can move water laterally from wet soil on one side of the plant to dry soil on the other side. Bioirrigation also includes capturing moisture from fog or rain deposited on leaves/needles and transferring it to soils in the root zones for daytime transpiration. In all of the above cases water movement is a night time process in preparation for the day's demands of plant photosynthesis and transpiration.

In the first two types of water transfer (wet deep to dry shallow, and shallow wet to deep dry soils) there are several important criteria for transfer success. 1) There needs to be a diversity of plant root systems (see figure 1). 2) Plant roots need to be in close proximity to each other. 3). A big plus is to create a soil rich in mycorrhizal fungi creating a *common mycorrhizal network (CMN)*. With this CMN tying water donor and water recipient together, water can be directly "piped" from donor plant to recipient plant via roots and fungal hyphae connections. Without the CMN, donor plants move the water to dry soil where it is picked up from the soil by the recipient plant's roots.

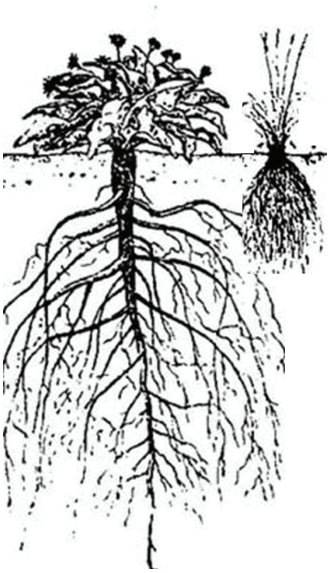


Figure 1. Tap root and shallow root crops

Bioirrigation is an important process in water limiting soil conditions, both in situations of too much and too little water. It can provide 15% more transpiration capacity and hence greater plant growth (and potential yield). Pigeon peas, pearl millet, and sorghum are examples of deep-rooted crops that can be interplanted with shallow-rooted crops such as finger millet and rice to take advantage of bioirrigation.

Bioirrigation increases plant growth and subsequent yields. Part of the story of yield improvement is that with bioirrigation, is simply making more water available in the soil. The other part is what the right amount of water in the soil does to increase biological activity (through rhizodeposition), organic matter decomposition (more nutrient availability), and nutrient movement (in water solutions); all of these come together to make more nutrients available to the plant. This movement of nutrients in conjunction with water is nature's way of "fertigation" (a combining of fertilizing and irrigation). Multiple studies with multiple crops have shown increasing yields and land use efficiency (more production per unit area).

Crops with large tap roots often have shallow roots as well (this is called a dimorphic root system). At night, the deep-rooted plant moves deep water (high soil moisture) to shallow (low moisture) soil. Daytime plant transpiration needs drives both shallow and tap-rooted plants to compete for the same shallow water. Both share in this water movement. **There is a production method that allows bioirrigation to be used exclusively by the shallow-rooted plant.** This is done by removing the above ground plant material from the deep-rooted plant, which leaves the shallow-rooted plant to have singular access to the bioirrigated water. A great example where I live in the Southeastern US is Sunnhemp (*Crotalaria juncea*). It is a summer crop planted right after early spring crops are harvested (bunching onions, spinach, salad mix, poc choi, beet greens, etc.) and then in August,

after two months of growth, the above-ground plant is cut off. Into this Sunnhemp stubble, autumn *brassicas* (broccoli, kale, cabbage, cauliflower, etc.) are transplanted.

In 50-60+ days, Sunnhemp grows 1-3 m and produces 90-145 kg (wet weight) biomass per metric bed (100 m^2) or 83-135 lbs biomass (wet weight) per US bed (100 ft^2), providing a lot of C and N for the compost pile. It is also a nitrogen-fixing legume, and supplies the soil with lots of N for the next crop (*brassicas* are heavy N feeders). Sunnhemp can provide 135-155 kgs of N per ha or 120-140 lbs of N per acre. Sunnhemp is also a good fiber crop and has been used in India for fiber for millennia.

Bioirrigation can help mitigate the effects of climate change in many ways. One example is in places that experience both flooding and/or drought in the same field any given year. Finding ways to reduce production risks is critical for a constant, steady, supply of food. One clever strategy involving bioirrigation is a closely-spaced, deep-rooted, drought-tolerant crop (i.e., sorghum, pearl millet) interplanted with a shallow-rooted, flood-tolerant crop (i.e., rice). In a drought situation the deep-rooted crop moves water from lower moist areas to dry upper areas to supply water to the rice. In flooding, the rice roots/plant supplies oxygen to the water-saturated soil helping the deep rooted crop to survive.

After 50 years of agricultural production and 30 of those years in BioIntensive (BI), I continue to be profoundly respectful of the fundamentally sound principles of BioIntensive. A summary of those BI supportive principles and practices for capitalizing on bioirrigation are listed below.

- **Deep soil quality** gives the roots the needed depth and soil structure for bioirrigation to work. And, in fully mature BI soils, tillage is minimized allowing for the development and maintenance of strong soil fungal networks (CMN).
- **Planting intensification** encourages and supports the close plant spacing and intercropping required for bioirrigation to work.
- **Functional Biodiversity** (also called companion planting) capitalizes on crops with diverse and dimorphic root systems.
- **Resource efficiency** focuses on water use, nutrient management and land use efficiency.
- **Carbon farming** for compost
- **Use of hand tools and permanent bed/pathway planting** allows close interplanting and above ground top removal of water nurse crops, very difficult to do mechanically.

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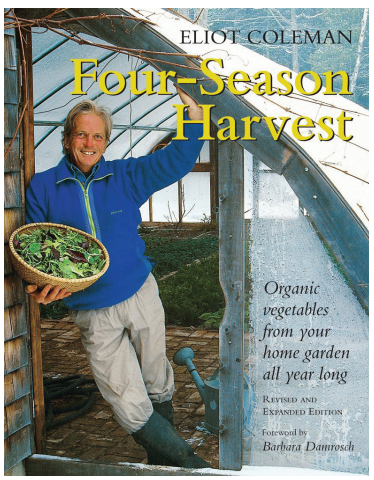
Winter Garden: Where and When

At the height of summer here in Northern California where The Jeavons Center is located, days are long and hot and it's almost impossible to imagine the cold short days of winter. But believe it or not, for farmers and gardeners in the Northern Hemisphere, it's already time to begin planning your winter garden. Here's a little help getting started.

Siting the Winter Garden

It is important to site your winter garden in a place best for the plants, but even more important that it be where you will remember to use it. Try to find a good place close to the door so you can check your plants as you come and go. It's a good plan to harvest dinner as you come home from work: you won't have to bundle up and go back out after you are busy indoors. Avoid low spots where cold air collects, areas the low winter sun doesn't reach, and areas that get waterlogged. If you can't choose a site sheltered from wind, it is very important to provide some shelter. A temporary fence, some branches, or straw bales can help. Good soil preparation is also key: plenty of compost will encourage good growth that is also hardy. Make sure there is plenty of potash, (greensand, ashes, or seaweed are good sources). This adds both cold-hardiness and disease-resistance. Seaweed increases cold hardiness and disease-resistance by supplying several other substances besides potash, and is a valuable supplement for winter gardens, either as mulch, as a soil amendment, or as foliar spray.



The serious gardener will want to consult the *Four-Season Harvest*, by Eliot Coleman, who gardens in Maine. This article borrows from that book, as well as from the experience of gardeners in England and the Pacific coast, including Southeast Alaska.

Choosing the Right Crops

Eat seasonally: the vegetables of winter will be different from the beans, corn and tomatoes of summer. Any crop where you eat the seed or fruit will not be available in winter; all winter crops are either leaves or roots. For many people, the big hurdle is learning to work more leafy greens into their meals—but doing so will benefit your health, as well as your budget and the planet. It's easy to add greens to soups and stir-fries; check the library or the internet for tasty recipes for cabbage, kale, and other greens, or concentrate on winter salad crops. Within each type of vegetable, some varieties are better for winter. Of course, cold-hardiness is one trait to look for in catalog descriptions. In rainy climates, rot-resistance, tolerance for mildew and mold, and tolerance for low light levels are important. Dry, windy climates like the Rocky Mountains require drought-tolerant varieties. (Consider misting your plants with water to form an ice barrier in very dry windy weather.) To see a list of Ecology Action's recommended seed sources. go to http://www.growbiointensive.org/BG

Timing: When to Plant

A good plan would be to look up your first-frost date and talk to experienced local gardeners about timing. If you live in a place where both days and nights are warm in summer, you will get faster growth than if nights get cold. Where we are, in the California Coast Range, summers nights are in the 50's and we plant all of our *brassicas* and fall onions by mid-to-late July. At lower elevations, people plant two weeks to a month later. Plant your *brassicas* like broccoli, cabbage, and kale, and then sow new seed every week or ten days until frost comes. If you live in a climate where days are warm after your first frost, keep making small plantings until days drop to 40 degrees, or the ground freezes. You can find your first-frost date on the internet (try https://www.almanac.com/gardening/frostdates) Or you can ask your local garden center, your local county agriculture department, or the Cooperative Extension Service of the State University in your county.

If you live in an area where the soil does not freeze (or not very often) and winter daytime temperatures are often in the 40's or above, your crops probably will make some growth in winter, and you can sow in cold frames anytime, though growth may be slow, and some day-length sensitive plants may bolt. In colder parts of the country, however, plants will not be in active growth. Instead, you will plant and grow crops in the summer and fall which will live through the winter. It is important to plant when the vegetables can get big enough to eat before winter but not so early that they get over-mature and lose eating quality. A long-season vegetable like leeks or cabbage will grow for 100 days before maturity, so plant them 100 days before your first-frost date in the fall. Root crops like carrots should be sown to be mature (or baby-carrot size) at first frost; then they you will mulch them, cover with plastic sheet or a cold frame, and dig them out a few at a time all winter.

Lettuce and spinach are more hardy as baby greens than they are as full-grown plants (in the wild they sprout in the first cold days of spring and go to seed in summer heat). A good strategy is to plant lettuce early enough to make nice heads for fall and early winter use, but also to make fall sowings throughout August (September if days are warm) for baby greens during winter. The very hardy salad greens (arugula, miner's lettuce,

mizuna, minutina) are planted at weekly intervals throughout August for winter use. The hardiest green of all, mache or corn salad, can be sown with them, and sowings may continue through September (October in warmer-fall areas). Kale is sown mid-summer, and overwinters as a mature plant. It can also go into salad mixes, in which case it is sown with the baby greens. All of these dates are for coastal New England: in many places frost and cold days will come much later and the planting dates can be adjusted accordingly.

Each sowing of seed need not be large. A short row or two square feet will be fine. Remember that baby greens can be thickly planted, but don't just throw the seed in. Plant individual seeds at 2" spacing for healthy plants and economical use of seed.

Two Gardens in One: A Nursery Bed is Like a Magic Trick

So, you're ready to plant your winter garden, but where can you put all of those little seedlings when your summer garden is in full swing? Many people wait until tomatoes and corn are over, so they have enough space, but by then it is too late and the plants never size up. Using a nursery bed is one of the tricks that can give you two gardens at once: your summer garden still in the ground, and your winter garden waiting its turn. Because the plants in the nursery bed are young, they are spaced closer than they will be later, so they take much less garden space.

How to Make It

A nursery bed is just a piece of ground cultivated to a crumbly texture so that seedlings can grow well. Add compost, which contains substances that trigger germination and growth. Your nursery bed can be an unused bed in the regular garden, a raised box made of wood or blocks, or even a large tub. At this time of year, it will need afternoon shade, so either site it to the east of something tall—like a house, shed, or row of corn—or use shade netting.

How to Use It

You can use a nursery bed, or part of it, for starting seeds instead of in flats or pots. But where it really comes into its own is to hold seedlings that are too large for the flat or pot and in danger of getting potbound. At that stage, summer crops are normally planted into their permanent places. In the case of winter crops, though, those places are occupied by summer crops that we don't want to disturb. Instead, put them into a nursery bed, where they can grow until early fall. It turns out that many winter crops like cabbage and broccoli actually do better if they are transplanted a couple of times. For example: You sow cabbage into a flat or pots August 1st. By Sept 1st, the seedlings are ready for transplant. But you don't want to tear out a row of tomato plants to plant cabbages! So you put them into a nursery bed, at 8" spacing. At that spacing, they take up only 12 sq ft. When the tomatoes come out, your 35 cabbages go in at their final, 16" spacing, filling 50 sq ft. Result: you get two crops from that garden bed instead of one.

Protection: Row Covers, Cold Frames, Greenhouses, and Fleece

You needn't make a huge investment in a greenhouse to have a successful winter garden. Start small. A plastic row cover (like a clear plastic tunnel 1 ½-3" high) will extend your season and go together cheaply and easily. You can even get them ready-made with built-in wire supports. For a really sturdy row cover that will resist wind, rain, and snow loads, use longer supports (flexible pvc pipe works well) and place them in an X pattern (looking at them from above), tying them where they cross. My method is to push flexible branches around the garden bed, bend them over, tie or twist them together, and cover with clear plastic, weighted with rocks or pipe. In heavy snow areas, sturdy end-posts and ridgepole of metal pipe or lumber can support the conventional wire, plastic, or sticks that hold the tunnel's shape, but don't forget to scrape heavy snow off the structure regularly to prevent collapse.

The next level of protection, and the most versatile, is a cold frame. This is a wood box with no bottom and a slanting glass or hard-plastic top. It is placed over the planting area, protects from wind and extreme temperatures, and can be propped open to vent on sunny days. It is easy to open the hinged lid and harvest food. Snow on the rigid lid can be left to provide insulation in very cold weather, or swept off with a broom. You can glue foam insulation on the box for extreme climates, and add plastic or fleece for cold spells.

Fleece, also called floating row cover, and often trademarked as Reemay or Agribon, requires no support (it "floats" on the leaves) and gives enough protection for spring and fall frosts. It admits enough light that it can be left in place. Fleece is a good choice for someone who doesn't want to have to do the venting or watering that greenhouses and other covers may need, but it can be crushed by snow and gives little shelter from excessive wind or rain. You can "stack" protection as weather gets colder: fleece inside a cold-frame or greenhouse for example. An extra sheet of clear plastic thrown over any of these covers will increase their effectiveness, especially if there are spacers to keep the layers from touching.

It is also surprisingly easy to make a hotbed: dig a hole 3'x4' and 2' deep. Fill it with manure or garden waste like grass clippings and straw. Then cover with 8-12" of dirt, sow seeds, and cover with a cold frame or plastic tent. The composting process will generate heat over a long period, enabling salad crops to grow all winter. This works well for spinach, lettuce, and the hardy greens, and was the main source of salad crops in Europe before the era of cheap oil. Plans for row covers, cold frames, greenhouses, and root cellars can be found in *Four-Season Harvest*, or check your public library. •

Ecology Action's Garden Companion

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Ecology Action Events: 2023

Dear GROW BIOINTENSIVE Family,

Our schedule (subject to change) of public events is as follows.

***Onsite* Garden Tour at VGFP in October:**
growbiointensive.org/events_main.html

***Online* Fall 4-Saturdays Introductory Workshop:**
Oct. 28, Nov. 4, 11 & 18, 2023. Register at:
growbiointensive.org/workshop.html

Our full 2023 schedule of events:
growbiointensive.org/events_main.html
or call 707-459-0150

Watch our 2-Week Farmer Training Course:
vimeo.com/ondemand/ecologyaction

Read our Farmer's Handbook in 9 Languages:
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Wishing everyone good health and good gardening!

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