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ADVANCING HEMP 2021

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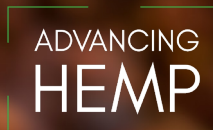
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HAILING HEMP'S VERSATILITY

This eco-friendly multipurpose crop has untapped agronomic potential

DR. FATEMEH ETEMADI

Our water, air and land are being polluted more than ever by textile manufacturing byproducts and plastic microparticles. With industrial hemp's resurgence as a cash crop and ability to integrate into regenerative farming practices, hemp might be the answer to our problems.

Hemp grows rapidly and has an extensive root system, making it a potential tool for natural weed suppression and enhancing soil health. Weed management is considered a perennial obstacle for existing organic farmers and a barrier for those considering transitioning to organic.

Successful weed management in organic systems often includes intensive tillage and repeated cultivation that can degrade soil health. As a cover crop, hemp enhances soil health by shading out weeds, reducing the need for synthetic herbicides.

Hemp, as a multipurpose crop, is environmentally friendly, can increase farmer income, is nutritious when consumed, and has many uses in agriculture and industry. As industrial hemp can be a good option in the transition to sustainable agriculture, Rodale Institute has conducted several experiments to gather crucial information to help farmers succeed and to examine hemp as a tool for regenerative farming.

In 2017, Rodale Institute initiated a four-year trial studying the effects of industrial hemp as part of a regenerative organic crop rotation to enhance soil health, increase crop production,



weed suppression, and improve organic fertility management when growing hemp in Pennsylvania. Subsequent trials added to this study include analysis of nutrient management, planting dates and CBD varieties. The overall goal of Rodale Institute's research into industrial hemp is to estimate the potential for this

crop to improve farmer success in a regenerative organic system.

The rotational research trial results indicated that hemp is a viable weed suppression cover crop that has higher economic value than something like sorghum Sudangrass, typically used as a forage for livestock. This may provide potential to reduce tillage in organic systems.

Soybean and wheat yields following hemp remained relatively high compared to other production systems on the Rodale Institute farm in Pennsylvania — often reaching or exceeding national averages.

In the nutrient management trial, we learned that hemp grain yield is increased with increased nitrogen fertilizer application. Sufficient nitrogen availability allows hemp to maximize growth and outcompete weeds at smaller between-row spacings (7.5 inch), while weed species outcompeted hemp in larger row spacings (15 inch) when nitrogen is limited.

In CBD varieties, CBD concentrations were highest with the application of straw and compost compared to black plastic mulch and bloodmeal (12-0-0) applied as fertilizer; however, plant height, width, branch number and biomass were highest in plants with bloodmeal and plastic mulch, resulting in higher total CBD yield. There appears to be tradeoffs between mulching types, increased nitrogen fertility, plant production and CBD concentration. Future research should continue to optimize spacing, fertility and mulching needs.

Since the launch of the Rodale Institute industrial hemp research program in 2017, public interest in our work has grown rapidly. In addition to attending conferences and meetings, Rodale Institute staff consult with farmers regularly across the Northeast and entire United States on growing industrial hemp in a regenerative way to determine how hemp can benefit farmers while mitigating environmen-

Left: Hemp fiber samples are studied in the lab. Below: A hemp field during harvest. Photos by Rodale Institute.



tal impacts.

In 2021, the hemp research program will begin to transition more research trials to the Pocono Organics site in Long Pond, Pennsylvania, and will include continued analysis of nutrient management, cover crops, reduced tillage and a selection of auto-flowering varieties for regenerative organic hemp production. Also, the Institute plans to test more varieties, specifically domestic varieties as they become available, and adjust planting date, harvest date, seeding rate, and spacing to maximize the marketability of the varieties for their intended use. This research helps us learn how to increase farmer income, learn more about seed and dual-purpose varieties and determine if they can fit into a grain rotation as a weed smother crop.



Dr. Fatemeh Etemadi is Rodale Institute's Post-Doctoral Research Associate in Industrial Hemp. Fatemeh is a Ph.D. graduate from University of Massachusetts, Amherst, with the concentration in agronomy and crop physiology. Fatemeh works on Rodale Institute's industrial hemp research. Contact at Fatemeh.Etemadi@RodaleInstitute.org

LEARN MORE:

To learn more about Rodale Institute work on industrial hemp, visit RodaleInstitute.org/IndustrialHemp.

An early bud forms on a hemp plant.



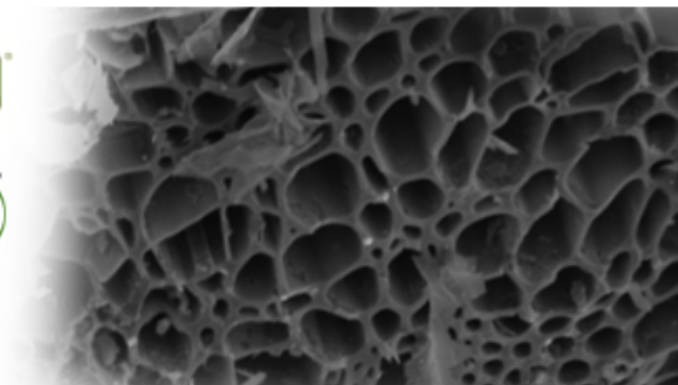
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A TRUE HEMP CULTIVATOR

Edgar Winters is watching the industry grow
up after starting his farm 55 years ago

ALLIE HYMAS



For Edgar Winters, hemp cultivation is an expanding horizon that has the potential to stand alongside other major agricultural commodities in the United States, while providing more value to the farmer through a more diverse product offering from the multi-use plant.

The Oregon farmer has spent his long career researching and developing hemp varieties for many uses, but particularly for industrial cultivation. His work in developing U.S.-based varieties for larger scale production has the power to put more value back in the hands of farmers. “We’ve been growing hemp strains for over 12,000 years,” he says. “We want to see good stable genetic strains in America that will last forever.”

Acres U.S.A. recently spoke with Winters about his impactful work and the future of hemp production.



Edgar Winters. Photo courtesy of the Mail-Tribune.

ACRES U.S.A. How did you get into hemp cultivation and breeding?

WINTERS. I started 55 years ago with medical marijuana. For the past 28 years I've been breeding medical marijuana seeds for patients here in Oregon; then when we got our hemp program initiative in, it was easy to switch over from the medical to the hemp seed. Back in 2014, I was awarded the first license for hemp in the state of Oregon in almost 80 years. Since then I've been doing hemp and it's my seventh year. I started off with fiber long before CBDs were even mentioned in the hemp equation. Now I've journeyed over into CBD production as well; I try to grow for all parts of the plant at present whether be fiber, food or medicinal purposes.

ACRES U.S.A. What hemp varieties are you known for and what makes them unique?

WINTERS. I'm mostly known for [a cultivar called] AC/DC. I've bred them for the last seven or eight years. Part of the CBD hemp comes from marijuana as well, so I've bred it over the years with different phenotypes to get the CBD version of a hemp plant which is basically half marijuana and half hemp, if you want to get technical about it, but it has less than 0.3% THC content. You can grow [my varieties] for fiber. I like some of the landrace strains we had here back in the 1940s when we were growing hemp nationwide. I've found a lot of feral hemp over the last five or six years. I collected them and crossed them with heirlooms and landraces from Asia and Russia. What we've tried to do is establish a phenotype with all three of those together. We [strive] for stable genetic strains for our local farmers here in America to grow hemp on a large scale, because we don't have many industrial grade seeds to grow for fiber or food. It usually comes from China, Russia or Canada. For the last five to seven years I've been developing American strains

that run the whole gamut from fiber, food, CBD and clothing. We determine what the farmer wants to grow for and then develop seed to suit [their] fancy.

ACRES U.S.A. What separates industrial varieties of hemp seeds from those for a smaller scale?

WINTERS. Industrial grade refers to growing agriculturally — in open fields and in large quantities. Eighty-seven percent of all Americans growing hemp for CBD do so on the horticultural end of the equation. Agriculture uses large, developed seed strains while horticulture uses specialized, crafted-type seed strains. There are so many different types of seed for different parts of the plant that it's gotten confusing for farmers. They don't know what the seed is or where it came from, or if it's stable or if it's the right seed for them. There are so many questions a farmer has to ask, and that's what we [address] in our company. We develop strains for local farmers' needs, that way they know where the seed came from and they're sure they're going to get a nice, stable seed content."

ACRES U.S.A. As you've developed your varieties, what qualities do you tend to select for?

WINTERS. I try to go for vigor; I want the plant to look big. Broad leaves means the plant is strong. I like [to see] characteristics that are dominant in the plant. Luther Burbank was a biologist in the 1930s through the 1950s for the U.S. government and he studied the cannabis plant, phenotypes and different characteristics of the plants. He said that when you see a plant you like, you mark it. Then when you find another plant you like that's totally different, but beautiful, you take those two plants and you cross them together. You're taking the best characteristics of both the plants and inbreeding them together to form a good phenotype. There are so many people breeding



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and crossing seeds that the government is saying we need to start certifying seeds. Several states have their own certification program; here in Oregon we have a couple that we use. The best thing a grower can do is certify their seeds through the department of agriculture. That way you know you're getting a stable, certified seed. Also for clones, clone the females so you get a nice flowering plant for CBDs. If you're after long fiber, you want to make sure those strains are very long and can be densified close together to make fiber products. It just depends on what you're growing it for.

ACRES U.S.A. What are some mistakes you see in beginner hemp breeders?

WINTERS. When I ask [a breeder] what they're growing for and they don't have a specific answer. Most growers are growing for CBDs, and CBDs alone, and I answer, "Okay, fine, but there are other parts of the plant." I have to educate them a little bit that there are several ways you can grow hemp for a living and for the production of CBDs. In Oregon we

have an oversupply of CBD products and in other states as well. When you're only growing for one part of the plant, you're going to have an oversupply. What we try to do is educate farmers and about other parts of the plant for fiber, food and clothing and not only for CBD. Now there are cultivars that have been inbred over the years through several different types of breeders that produce several different characteristics in one plant instead of having to grow different types of plants.

ACRES U.S.A. Why is it important to have hemp varieties native to the United States?

WINTERS. In Europe there is only one type of strain they grow for hemp — monoecious, which means the male and the female are on the same plant. The other variety is dioecious, meaning the plant can be either male or female; not both: one or the other. In Europe all they grow is monoecious because they're growing for fiber and seed. Monoecious has more pollen and seed

Edgar Winters teaches Doug Fine, author and hemp grower, about determining plant gender.



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content; the only problem is monoecious is a man-made strain, it's not in its natural state. So you have to worry about cross pollination if you're growing hemp for industrial grade seed alongside a farmer growing hemp for CBDs. I don't deal in monoecious at all; I try to stay in dioecious. Now if you're going for CBDs most all your farmers are strictly wanting feminized seed to make sure they're all females so they're sure they won't have any cross pollination with males during the process. It's gotten to be a lot more complex now than when I started out as a seed broker. I have strictly male and female seeds: American strains developed here on the farm. Right now most of my work is done in research and development. I developed some strains through Cornell University, University of Virginia, Louisiana State University, Oregon State University, and the list goes on, and they've [studied] all my 17 cultivars. They've been studying them on a larger scale to determine exactly what phenotypes they are. Are they stable? Are they the type of plant we here in America want to develop, or do we want to try European and Canadian cultivars? I'm happy to say most of our seed stocks here in Oregon are American strains and we don't have to source out for seeds.

ACRES U.S.A. What's happening in the broader community of hemp production and how does it impact what you do?

WINTERS. Right now I won a government bid contract to do feasibility studies for processing mills. At present in America we have no processing mills for farmers to bring their products to market. They don't know what to grow because they don't know how to get rid of it at the end. Before we can have farmers grow industrial grade we've got to have processing facilities that can take those products and break them down

into byproducts on the industrial hemp scale. Right now we're working on the east coast — Maryland, West Virginia and Pennsylvania — and we're trying to develop a processing facility for farmers to bring in their products and get paid. We found that if you can keep the mill within a hundred miles of the farm, it greatly smooths out the processing ability. A mid-sized processing mill requires forty thousand acres of hemp production to supply that mill for the year, working eight hours a day, five days a week. Institutes that are studying hemp find that in order to have a viable industrial program in the United States it has to be grown on a large scale.

ACRES U.S.A. As you consider that scale, how do you maintain integrity and make sure the farmers keep their share of that commodity's value?

WINTERS. We find that the hemp industry has such true value-added products because you have so many parts of the plant. So the farmers need to cut out the middleman and get those added values for every part of the plant. You take the stalk of the industrial grade plant and you get long fiber for textiles or rope, the hurd part which we use for animal beddings and hempcrete out of that; you can take the seeds and replant, make food products or press those seeds into oil. The farmer is realizing that there are a lot of end products they can get out of one plant and that's what we're trying to do at Winterfox Farms is make sure the farmer has complete control over what [they're] doing. We're more into the co-op model of doing things because hemp is such a wonderful plant that's been around for so many thousands of years. It's more than just a commodity — it's a way of life.

ACRES U.S.A. What parting word of advice do you have for someone who's interested in growing and breeding hemp?

WINTERS. First I'd say start backwards. Start with what you want the

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end product to do and then work yourself back to the beginning on how you want to achieve that. Most farmers just jump in and then they learn by their mistakes. In the hemp industry these days, there's so many guidelines that need to be followed to be successful. I would recommend all farmers to get more educated in the hemp industry if that's what they want to do because it is a new industry and there are a lot of rules and regulations. It's still in the early stages. Start slow and start easy because it takes a lot of money to grow hemp from seed to shelf. Talk to other farmers, such as myself, who've been growing hemp over the years because we're more than willing to help you along your way. See what your other local farmers are doing in your area and get together as a co-op, see if industrial hemp is something you can grow together. If you were growing soybeans, once you process it you'll get about from 80 to 96 dollars an acre, but if you're growing hemp instead you're average [yield] is going to be anywhere from six to seven hundred dollars an acre. Not very hard for a farmer to figure out.

Learn more about Edgar Winters, his hemp seeds and his consultation offerings for cannabis breeders and growers at www.winterfoxfarms.com.



Top: Edgar Winters speaks at an event in 2018. Below: He teaches Doug Fine, author and hemp grower, about hand-pollination.

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MID-SEASON PROBLEM SOLVING

What to expect when you're expecting
(a hemp harvest)

DOUG FINE

It's July. Your hemp is growing an inch or more per day. The field looks good. Or maybe one section less so. In your rookie season, perhaps understandably, you tend to panic over variations in the crop. First time parents don't know what to expect. And if you see, as I did in one client's crop, a yellowing edge around the leaves in once portion of a large acreage field, you quite naturally fear the worst and start intensely researching the situation.

Your first question, if you're wise, is, "was this field planted in healthy soil?" If the crop is phyto-remediating a field healing from monoculture and associated pesticides and herbicides, anything is possible in terms of plant display. But there are signs in fields with problematic spots that could mean a nutrient deficiency or surplus. For that, your best move is to get online and do the research – cannabis bloggers often provide top-notch advice on leaf discoloration

For instance, a yellowing on the leaves in a jagged pattern can mean a sulfur deficiency. Curling top leaves can mean overwatering and the threat of root rot. The reality is, though, hemp is hardy plant and field problems most commonly derive from genetics or soil quality. They are, in essence, off-season issues that you can address as best you can, with organic inputs, while planning ahead for more robust soil building next season. But, even as you deal with field issues, the veterans I've learned from tends to focus on three issues: drying the crop, conducting early cannabinoid testing, and, when planting a dioecious crop, gathering

pollen from male "unicorns": favorite individual plants whose traits you'd like to select for.

Dial in your crop drying and cleaning now, in midseason, as it has to be handled immediately upon harvest. The scariest part of harvest, and arguably the most time-sensitive, is not the harvest itself. It's the two hours following harvest. This might be the most overlooked component of the hemp season I've noticed in first time commercial hemp farmers. One year a colleague thought she had prepped her drying protocol well (so did I), with a commercial drying and cleaning facility located two hours from the field. The full harvest — 60 acres — required two trips because, well, there was a lot of hemp. The four-hour delay for the second load of the harvest wound up costing the project a couple hundred pounds of seed.

Here's the must-know piece of intelligence: The moment you harvest your hempseed, the clock is running to get it down to eight percent moisture. That's because the instant your crop leaves the field and is deposited in a bag or silo, it starts to compost. The



The author holds his friend, Izzy, in his field. This article is an excerpt from Doug Fine's Acres U.S.A. online course, "A Grower's Guide to Regenerative Hemp: From Soil to Seed to Sales." To sign up for the comprehensive grower's course, visit [learn.acresusa.com](https://www.acresusa.com).



reason this happens is that hemp is harvested “greener” than many hemp crops. Your initial harvest, in fact, is a mass of green chaff: It looks like lawn shavings. Sometimes you can barely tell there are seeds in there. The crop can come out of the field at 20 percent moisture or higher.

That’s a lot of water. Try sticking your arm in a batch of hemp 15 minutes after harvest: It will be burning hot. You’ll be steam-scalded to your clavicle. Your harvest is cooking. Immediately. Now it’s a sprint: you have an hour or less to get going on the drying process. It’s firefighter-mentality time. And it’s why the farmer’s first midseason task is to dial in the whole drying and cleaning process well before harvest time. It is hard to overstate the imperative of getting you crop dried immediately on harvest day. And the time to get this all dialed in is now, in the dog days of summer.

Here’s what you would be wise to do, ideally on site or as close as possible to the field: There are standard ways to get you harvest dried and, let’s say, more creative ways. In 2018 in Vermont, we used a nearby organic popcorn farm’s drying facility. Solar-powered too. But not everyone has access to popcorn facilities. What most everyone does have access to are large fans. And these, alongside some sort of ventilated storage bin (like a small grain silo) and a decent-quality moisture tester, are what you’ll need.

Your silo should have a grated floor, allowing forced air in care of your fan (heated if local relative humidity demands, generally meaning if you harvest in cold, wet conditions). Whether you have harvested by hand in bag, or with a silo, immediately place your harvest in this ventilated silo, rotating frequently (by hand with a rake or shovel unless your silo is fancy enough to have an automatic churning mechanism). These first 24-48 hours are crucial. Get yourself a moisture tester, and keep the process going until

your crop is down to eight percent. Then run it through a seed cleaner.

Adding fun for the nascent hemp farmer is that for now all but one brand of moisture tester — the Dickey-John Grain Analysis Computer — lack a calibration level for hemp. And the Dickey-John is expensive, around \$4,200. Luckily, you and your harvest team can get hold of the much-cheaper handheld field models (which start at around \$90-\$250). When you employ one of these, you get to poll one another about similarly sized seeds and then average out the results of several settings: barley, corn, and amaranth, or whatever. I find the readings are usually pretty close to one another. Close enough.

Forced-air drying in a silo (some call these grain bins or silage bunkers) is not complicated. Depending on the size of your crop, your close-by silo doesn’t have to be huge—just able to hold about 1,000 pounds of seed per acre of field, plus associated chaff. The silo has that ventilated (grated) floor. Below the floor, place a huge fan.

Once you (or your combine or your oxen) deposit the wet harvest mass in the silo, snap on the fan and take a deep breath: You have started the drying process. Then spend the next 24 to 36 hours turning over your green mass with your shovel. Do this hourly. In years where we’ve dried in a silo, I love hopping fully into the silo, breathing terpenes, and rotating the deep hemp carpet.

The goal is to get the seed dry enough before it overheats and rots into a sterile mash. It’s simply amazing how fast this happens — within two hours of harvest. So if you have to go off-site to your own or a commercial drying facility, you’d better get your entire harvest there, fast. That experience is why I believe on-site drying facilities are a worthwhile investment.

There’s one more step once your seed is dry to eight percent mois-

ture: Get it into the seed cleaner. A seed cleaner is a simple multilevel agitating machine that resembles an air hockey table. It shakes vigorously, shrugging off the chaff through progressively smaller screens; after you run your seed through it once or thrice, you end up with squeaky-clean seed. We'll show you a seed cleaner in action in Chapter Six.

Now your seed is ready to be replanted, sold whole, or turned into pricey hemp hearts (this requires a de-huller), omega-rich hemp oil, and my goats' favorite: hemp-protein powder. More immediately, your seed is now ready for storage in the temperature-, moisture- and rodent-controlled facility for which you've been preparing instead of worrying only about some leaf discoloration on one of your aces.

Today, unless you splurge for jute bags and until someone markets bio-fiber grain bags, there aren't many great options for storage sacking. Some folks like vacuum-sealing their product (especially flower) in nitrogen within Mylar bags. That's not my personal storage choice.

At every stage of the farming cycle, I like to ask, "How would the shaman have done this?" And Mylar just rarely comes up. So today it's hard to avoid the woven plastic fiber of one-ton grain bags. They do the trick but it's just more plastic junk around the farm. I can't wait to wean from these. Still, once the seeds are dried, cleaned, and stored, your harvest is safe.

Until THC worry goes away for farmers (and many folks including myself maintain it will, because it must, in order to free farmers to develop and grow the plants they want to grow), expect to be awakened with some form of the call I received from a colleague midseason in 2018 that said, "Does 0.33 percent mean 0.3 percent? The state should round down, right?" So the smart move



A sample from Doug's field.

is to start doing your own testing well before harvest. Just so you have a handle on how your cannabinoid profile is developing. Test in the morning. Test in the evening. Test flowers. Test leaves. Test your big plants. Test your small plants. Lobby for the essential first step change to a one percent THC definition -- and we'll discuss this in detail in our policy Chapter.

If you're wondering if all this testing can get expensive, indeed it can. If you have a good relationship with a testing outfit, you can keep each test under \$100. It might also make sense to take the plunge and invest in one of the newfangled handheld testing machines. These start at about \$700. They aren't as accurate as lab-level machinery, but they give you an idea of your cannabinoid levels, and once you own the gear, you can conduct as many tests as you like. Plus you can check your test against a professional lab's (or a official state test's) result.

What if even your midseason tests start creeping close to that (soon extinct) 0.3

percent level? First, congratulate yourself for being a good farmer. But now you've got some tough decisions to make. Do you hobble your plants so that they don't risk destruction due to inane laws? Do you (gasp) consider harvesting early and subjecting your customers to an inferior product? There isn't an easy answer to this short-lived dilemma. The good news is our kids will laugh that we had to sweat about these kind of chemical issues in the field. The same cultivar can test five times higher in THC in one location versus another, and THC levels vary in a plant over the course of a day. So test early and often.

Since we're farmer/entrepreneurs now, we're looking for special plants that will provide exactly what we're looking for in harvest – maybe strong fiber, high protein seed, or a flower with an Entourage Effect that we believe separates our product from the pack. Peak of the summer is when to collect pollen from your favorite males, as they die back after pollination.

Indeed, one of the most beautiful parts of owning our own genetics is we can develop them over time, like Gregor Mendel, the famous 19th-century monk we all learn about in grade school by sprouting beans in a cup. If you're in the dioecious camp, the time to capture male genetics is when your male plants are ripe and ready to pollinate. By August your males will look completely different from the females. The vertically stacked pollen sacs are the giveaway. Also the bees gobbling them. It's not hard to tell when a male flower is mature—brush against it with the force of a butterfly kiss, and pollen will leap off in a dusty little cloud.

Unicorn hunting involves looking for a specific few plants you like, either because of the way they grow (say, their branching structure, their

height, or their lack of height), because of their rapidity of germination, rate of maturation, or because of the color of their fiber. Maybe you've just had a good feeling about a particular plant all season.

To capture hemp pollen, place a small paper or cloth sack over the male cola (top) flower overnight, bind it at its opening (I use hemp twine, needless to say, but a rubber band can work), and collect the pollen in the morning. Label it (with date, cultivar, location, and what you like about it), and refrigerate it. If you're growing strictly for a female flower harvest (sinsemilla), by August you'll start "sexing out" your plants — this being several weeks earlier than full male maturity. The reason for this is that you want all your males out of the field or greenhouse before they pollinate.

This is beyond safe sex for plants. Let's call it what it is. You're a dang hemp Puritan when you cultivate this way. But it is what most folks do at this moment in the industry's evolution (assuming they aren't growing clones or "feminized" genetics). That's because it's what the market currently demands if you're trying only to maximize your CBD percentage (or the level of some other cannabinoids that reside in the female flower).

I've become competent at this process, studying the (usually) sixth "node," or branching, from the main stem (counting from the base of the plant), about four to six weeks after planting. You're checking if the first flower nubbin is taking a distinctively male or a female form. Gender is already discernible even in the very early flowering stage, with the female shape more of a branching pair of "bracts" with small hairy stigmata emerging from each, and the male pre-flowers looking like small round sacs. [i] Both are tiny at first, the size of BBs or smaller. This is why I like to examine the young flowers with my pocket scope. But if I'm decently adept at this process, my colleague Margaret Flewellen, who is married to Edgar Winters, is a savant.

Success!



She can sense a plant's gender at a glance, the way a professional poultry sexer can look at an hour-old chick and tell whether it's a pullet or a future rooster.

And as in a chicken yard, where farmers of a spiritual ilk believe that a rooster in the yard makes for happier and more productive hens who lay healthier eggs, you needn't remove your young males right after identifying them. I notice that even in his sinsemilla gardens Edgar shares this belief in a goal of hormonal balance in life. He'll keep some males in the field until near maturity. You have plenty of time — several weeks — to remove the males after identifying them.

Now back to our dioecious crops. The reason, as Edgar and I discuss in this chapter's video, to "bag" the cola flowers of your favorite unicorns at pollination time is that male plants generally die back after pollination. So this midseason moment is your window for saving genetics with a Y chromosome. Since they depart on their own, I don't usually pull the males after pollination, though Edgar likes to.

Then, in the greenhouse or in the field, you take the step that always reminds me how important it is to own your own genetics. It still blows my mind that this soon-to-be-multibillion-dollar industry hinges on delicately applying individual pollen grains to female hemp flowers with the kind of brush you'd use to detail a model plane. Smaller than

you'd use for brushing a toddler's teeth. It's always a surreal experience to do this under Edgar's and Margaret's guidance. (You can also pollinate specific females in the field with the pollen you've gathered, but you'd better tag the plants so you remember which seeds to save.)

"See how the females here are ready, too?" Edgar will say, looking over my shoulder. "You only have a couple of days' window when the female flowers are receptive."

At the same time we have a quarter of a million plants maturing an inch and a half per day outside, we become this nursery, working to advance our genetics to a place that works for our products. And there's not a test tube or toxic substance involved. Flower by individual flower, innovation starts with that unicorn that gives you the properties you're seeking. And so an ancient industry is reborn in the digital age, care of an Austrian monk. Spending some time at midseason identifying your favorite plants of both genders is as vital to any agriculture-based endeavor from here on out as water and sunlight and, for that matter, sufficient initial capital.

Doug Fine is a journalist, goat herder and hemp farmer in New Mexico. He is the author of Hemp Bound and American Hemp Farmer. You can find those at www.acresusa.com.

HEALTHIER, STRONGER HEMP

Why your CBD crop needs to be nutrient dense, and how to keep it that way

BOB WILT

Should you worry whether your hemp crop is nutrient dense? The short answer is yes — but why? First-time growers often think because the hemp plant is an aggressive scavenger of soil nutrients it does not need added fertility to grow. This is half true. Hemp will grow on surprisingly little inputs, but will not come close to its genetic potential without a smorgasbord of luxurious amounts of plant available minerals and nutrients.

The grower needs to understand that his goal is to produce high percentage, high quality CBD oil, along with high numbers of terpenes. These compounds are considered secondary metabolites. As the plant becomes more nutrient dense (energy dense) the more it can make secondary metabolites — in this case CBD oil and terpenes.

Farmer and consultant John Kempf illustrates of this with his Plant Health Pyramid. It shows that as the plant climbs up the levels of health the plant will produce more complex sugars and complete proteins upward to fats, lipids and oils and finally to secondary metabolites. To climb to level 4, the plant requires maximum high levels of energy from mineral nutrition. Another term for mineral nutrition is nutrient density and can be measured as sap Brix using a refractometer.

Many times, conventional NPK crops are below level 1. This is where disease and insects are prevalent and there is minimal nutrient density. From my experience the way to start raising the levels of plant nutrition is to encourage and feed soil microbes and remineralize the soil with a complete

menu with as many as 79 minerals. Soil microbes will solubilize these needed minerals into a form that the plant can take up, and this, along with increased photosynthesis, is the beginning of becoming nutrient dense. The more that this process happens, the higher the nutrient density becomes — hence the higher the level of plant health and energy.

It is this increasing plant health and energy that allows the plant to make more increasingly complex compounds such as complex sugars, complete proteins, fats lipids, and oils, and ultimately secondary metabolites, including antioxidants. It needs to be understood that at the lower levels of nutrition, little CBD oil or terpenes will be made. At this low level of energy, the plant is doing all that it can to survive insects, disease and environmental stresses. There is nothing left to build complex compounds.

Other implications of nutrient density are resistance to insects, disease and environmental stress. As nutrient density goes up, as measured by Brix levels, insects and disease go away. To quote Carey Reams, “When the

Bob Wilt on his farm with his blueberries.



Brix of the whole plant is above 12 insects and disease will go away.” Insects will go away because as sugars and proteins become more complex and complete, insects cannot digest them and will die. As for diseases, when Brix goes up so does mineral concentration. It is a well-known fact that diseases are a manifestation of a shortage of specific minerals depending on the disease or mineral imbalance. Because I do not know or completely understand all the relationships of diseases and minerals, I like to mineralize the soil with a complete natural mineral source using between 60 and 79 minerals in the form of rock dust or concentrated sea minerals. I have found that if I do not know what I am doing, give Mother Nature the tools and let her fix the problem.

When it comes to environmental stress such as heat, nutrient density comes into play by helping the plant to get to level 3 where it is making oils, fats, and lipids. At this level, the plant has enough energy after surviving insects and disease to start form-

ing sugars into more complex carbon compounds such as oils, fats, and lipids among other compounds. Also, the plant will start depositing these surplus compounds on the leaves, roots and stems as a store of energy to be used in stressful times. This is when the plant will “stockpile” oils, which is what the hemp grower is trying to accomplish. Then with a little more nutrient density the plant is at level 4 making multiple cannabinoids and terpenes along with antioxidants.

From a regenerative point of view, when there is a surplus of nutrient dense complex carbons such as oils, fats and lipids along with sugars they will be exuded out of the root tips and made available to feed the soil bacteria and fungi, which will digest these carbon compounds into humus and future plant foods. It should be noted that the above principles apply to all crops from hemp for CBD, seed and fiber to fruits, vegetables, nuts, grains and forages.

Bob Wilt is a blueberry and hemp farmer as well as an ag consultant based in Oregon. Contact him at westernaglands@gmail.com.



A hemp farm after harvest. Photo by Rodale Institute.

HARVESTING HEMP INNOVATIONS

Equipment improvements abound as the U.S. industry struggles to take hold

DARCY & DALE CAHILL

Although 2019 was a tough year for hemp farmers, many have not given up on the crop. Many hemp farmers and farm equipment manufacturers are still excited about the crop and are eager to see their newly designed small- and large-scale equipment put to the test this season.

These improvements are, as always, guided by increasing efficiency and maintaining high quality standards. This year's hemp farmers, whether harvesting grain, seed, fiber or CBD, will put their innovations to the test. Those innovations include retrofitted farm equipment, specifically designed harvesters and specific low-cost tools used every day to improve, protect and bring hemp to market.

Bish Enterprises, located in Giltner, Nebraska, has served farmers in the Midwest for over forty years and is recognized as one of nations first manufacturing innovators to specialize in hemp farming equipment. Their interest in developing hemp-specific farming equipment began one day in 2016 when Andrew Bish stood out in his sorghum fields near the Kansas-Colorado border. It is there that he realized that hemp may well be more sustainable and viable than other grains. By 2017, Bish had learned enough about the labor-intensive costs to growing hemp to begin imagining ways to save money. That is when he established Hemp Harvest Work, which researches, designs, engineers and works in tandem with manufacturing companies, including Norsemen, Checci & Magli,

John Deere, Farmer's Edge, and PureHemp Technologies, to help them adapt their hemp equipment.

Bish started his research with grain and fiber hemp.

"I became smarter with each harvest and by talking to hemp farmers about what does and does not work with their harvesting equipment," he says. "These conversations also began to shed light on what was driving the hemp market."

He has since turned his attention to harvesting and processing all forms of hemp. Hemp Harvest Works' current research and development efforts are focused on perfecting the Bish Separation System, designed specifically for harvesting cannabinoid rich hemp.

According to Bish, "the first stage of separation takes place when dry hemp material is fed into the machine where it is broken down and threshed to remove the hemp stalk from the rest of the hemp 'biomass.' The second stage separates hemp flower from hemp seed, while also removing additional woody material. The seedy material is then fed into additional seed cleaners to recover additional flower, and separate viable from non-viable seed. No screens or sifting is necessary."

Additional vacuum systems can also be installed to minimize trichome material loss. The Hemp Flower Separation System is capable of separating hemp flower from stalk and seed at a rate of 2,000 - 4,000 lbs. / hour.

This fall, Bish has spent his time putting the Bish Separation System to work in hemp fields across the Midwest, as well as in Colorado, Tennessee and North Carolina. Despite being allergic to hemp himself, Bish knows that the most valuable feedback he can find comes from hemp farmers themselves who are amid harvesting their crop. He started his research in Grand Junction, Colorado, and when we caught up with him, he had spent the week demonstrat-

ing the Bish Separation System with a farmer in Kentucky. The farmer grows hemp for a smokable flower, and in order to improve his yield and ensure a high-quality flower, Bish made adjustments to the machine by adding more layers of separation.

Another commercially scaled piece of hemp machinery on the market this year is the Super Clean-Cut Hemp Harvester. Designed in partnership between Bish Enterprises and Formation Ag, the Super CleanCut has a modular design and harvests in row spacings from 20" to 60", or even wider. According to the Formation Ag web site, "it is available in a one row model, and up to 6



row configurations. Super CleanCut can be driven by power units with a horsepower greater than 50 HP. This completely scalable design allows the Super CleanCut to be used on smaller grows, or large industrial-sized operations, and can be set up for wide or narrow row spacing.” The Super CleanCut addresses what has been a persistent problem when trying to use traditional harvesters for hemp as it reduces or eliminates wrapping issues, which can dramatically reduce efficiency in the field.

In conjunction with Jones Harvesting LLC, Hemp Harvest works came out with The Budd EZ several years ago. Jones Harvesting describes the

bud harvester on the website as being designed to increase the efficiency of the de-budding process. Their website also emphasizes that the harvester leaves no waste. “The stems of either freshly harvested or dried material are fed into the machine. The holes in the plate are sized to only allow the stems to pass through. Rollers pull the stems through the plate and the plate leaves and buds are clearly striped off and fall into a collection bin. The stems are also collected in a bin on the other side of the machine.”

Always aware of non-commercial operations and affordability, Bish is in the process of redesigning the Budd EZ for the 2021 season, making it



A Bish hemp separation system.



available in three different sizes, which will help to lower cost for smaller hemp operations. His company has made similar changes to the Super CleanCut, which was originally designed to hitch to 80 HP tractors. Their newest version works with 50 HP tractors making it more viable for hemp farmers looking to harvest single rows.

Sunsoil is a noncommercial operation that is ever aware of the bottom line. Sunsoil, located in northern Vermont, was started by Jacob Goldstein and Alejandro Bergad in 2015 with five acres of hemp. Since then, Goldstein and Bergad have gradually expanded their operation to 80 acres and are involved in every aspect of operations, including breeding seeds for specific genetics, planting, harvesting, drying, processing, extracting oil, packaging products and marketing them. Their farming, harvesting, drying and extraction tools and methods have evolved over time. Gradually, they have come to realize that there is no tool or piece of equipment that can replace the human touch.

During their first season of farming hemp in Vermont, Goldstein and Bergad, relied on their hands and traditional farm equipment. Instead of using clones, they planted their seeds in greenhouses and transplanted their seedlings all by hand. They managed their beds with DR field mowers and weed trimmers outfitted with metal blades. They harvested their crop by hand with loppers and loading the plants onto trailers pulled by 50 horsepower tractors.

Goldstein says that they still use these hands-on methods and machines. While he would love to be able

to use custom machinery to increase efficiency and profits, the high quality of his CBD plants demands intensive oversight. The area where he and Bergad then devote most of their research and development is in seed propagation and achieving greater efficiency in breaking down their harvested plants.

It is in their barns, all built specifically for drying hemp, that they have made some of their most effective tool and equipment improvements. Each year Goldstein and Bergad sit down together after their harvest and look for faster and more effective ways to fill, empty and bag their crop. Five years ago, they cleaned plants over barrels, they now customize the height of each break down tables to suit each employee. This allows them to work more comfortably which in turn increases efficiency. They have also redesigned their in-barn plant movers — what they call their “space-ships” — so that they can handle more plants and more easily move through the barn. When asked to identify a piece of equipment that would most positively impact their operation, Goldstein said he’d like to see a quality controlled hemp harvester that could equal the gentle touch of human hands and the eyes and experience of a veteran hemp farmer. One can dream.

Although many hemp farmers new to growing hemp in 2019 were left empty handed, that has not stopped them and the farming equipment manufacturers from looking to increase efficiency and lower costs for their 2021 season. And many believe the future for hemp is bright. According to hemp industry and trade journals, there are more than 50,000 different uses of industrial hemp from textiles to sustainable building materials to food and potential energy sources just waiting to hit the market. With the resolution of legal and regulatory issues constraining hemp production, hemp farmers will be able to move into the hemp markets with greater confidence and finally be able to put equipment innovations to work.



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