REDUCED TILLAGE FOR VEGETABLE PRODUCTION

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Dancing the Land Farm

Location	Ferryville, Wisconsin	Clearwater, Minnesota
Acres in vegetables	2	4
Mechanization level for most field operations	With tractor AND by hand with hand-scale tools	By hand with hand-scale tools
Farming style	Certified Organic	Non-certified organic, primarily no and lo-till systems.
History	Before we founded Circadian Organics in 2018 some of our fields had been fallow/pasture and some had been corn/soy/hay rotation for about 18 years, and a smaller section had been the family garden. I grew up on the farm and my parents ran a CSA from 1993-2000, so I know the land well. I studied cover crop-based reduced tillage methods while I worked at UW-Madison. We worked to use reduced tillage and permanent coverage from the start of our farm, but that has evolved into more of a rotational tillage approach (every 2-5 years depending on plot, and tunnel vs field)	I've been farming since I was 19, working at several farms in Northern California, before moving back to my family's land in Central Minnesota to stat Dancing the Land Farm in 2012. My parents bought this farm in 1973, and since they were not farmers, they promptly kept up with the rental agreements a local grower had already been maintaining with the tillable acres. This land was put into corn every year, without rotation, for longer than I've been alive. When my now-husband and I came back to start a farm, you couldn't find an earthworm, and the ponds has almost no frogs; the soil had zero structure, no organic matter, and so little bio activity that you could find corn cobs and corn stubble in the soil for four years after the last crop. The soil basically served as inert media to hold corn roots and anhydrous ammonia. Our first years were spent rehabbing the soil: soil testing, cover crops, what compost we could afford, chicken tractors, goats and sheep, haphazard mulching, biodynamic soil preps, green manure, biochar, and anything else we could think of to get the fertility cycles to start again, and organic matter back in the soil.
Key motivations for using reduced tillage methods	Mostly system resilience - water infiltration and slowing runoff or floodwater during extreme rain events, and reduced disease and pest pressure from building long term soil fertility and soil micro/macrobiota.	Primarily we were trying to make friends with water. The first fall we put in no-till beds was after a huge spring flood that had set us back two months, the tillage we had been employing was obviously contributing to the problem as no water was able to perc through the hardpan below the surface fluff. The next year we went into a pretty severe drought cycle, and the no-till beds by far and away the most vital places on our farm. The no-till beds had a lifeline to the ground beneath them that our tilled beds couldn't access.

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Key motivations for using reduced tillage methods, continued		Secondarily, we were trying to find a solution to weed management that wasn't so labor intensive, as we were relying on hoes and hands. Covering the soil is by far and away the easiest and least disruptive method that we've tried. Thirdly, we knew a major issue with our fertility and water holding/draining capacity was the severe lack of organic matter in our soil. And we knew that no matter how much compost we used, tilling was burning up all the organic matter.

Main low/no-till production method

Description	Our primary method is basically transplanting into untilled ground. We do our intermittent tillage and raised bed building with a tractor in the field, intermittent tillage in the tunnels with a BCS. In the tunnels we primarily have permanent beds, top dress fertilizers and compost, and mulch over top of that with straw or landscape fabric. We transplant using hori hori or a bulb auger. In the fields we have semi-permanent raised beds that we leave established for 2-3 years, using living mulch or organic mulches in the paths and plastic or landscape fabric in row for transplanted crops. We transplant by hand for everything, even alliums. The rotational tillage is mostly driven by tilling before early direct seeded crops like carrots, radishes, beets, etc. However we will direct seed the same crops no-till following early crops like lettuce, onions, etc once we pull the mulch off. Often reuse the same planting holes for transplanting fall crops. Fertigation and foliars are key in our system.	Our main No-till method is permanent bed installation and maintenance. 1. We do start with tillage, as our soils tend to compaction and the first year the plants need a little fluff to get going. 2. After we till we measure and mark out our beds with flagging, then compact the soil on the pathways with our truck tires. This makes a slightly raised bed. We use 4' bed tops, with ~2.5' pathways. 3. We then lay out 3' landscape fabric on the pathways and secure with earth staples. We make sure the fabric comes up the bed shoulders, as the shoulders are always the weak spot and the first place weeds will come in. 4. Then we load our truck with mulch, back the truck down the beds and unload at least 4 inches of mulch on to the bed tops. We have a truck-bed, hand-crank conveyor belt that works pretty well, but we've also just used pitchforks sweat. 5. Taking care to ensure that the mulch layer maintains full thickness onto the shoulders and overlapping with the landscape fabric is key. 6. Then we plant right through the mulch into the subsoil with our stand-up transplanters. Depending on the crop we'll lay drip-tape before we plant.
Used for the following crops/crop families:	Best results attained with solanaceae and cucurbits, decent success with brassicas esp leafy greens (also chard). .	Transplants with a bit of height: ex: brassicas, leeks, snapdragons. No basal rosettes, like lettuce or statice as they'll just get buried--though I have had good luck with artichokes.
Favorite features	Sometimes less work (sometimes more tbh). Soil health and less disease. Beneficials populations. More pleasant to work in and aesthetically.	Slightly raised beds means that when there is flooding the beds offer contours that disrupt water flow so we get less erosion. The water holding capacity is enormous. And the beds drain way faster in our problem wet areas than they did before. 'The worms and roly poly's and other soil creatures do the work of fluffing the soil for us. Well-maintained beds get lighter, fluffier, and deeper the longer they're maintained. Because the soil is covered, weeding is minimal.

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Main low/no-till production method, continued		
Key considerations	Weed control! That's why we keep everything covered, so direct seeded crops and those that really need to breath don't work well.	Always consider your location in all seasons, notill is really about ending agricultures antagonistic relationship with the natural world, and working with natural processes to create the circumstances that are also conducive to human thriving. In that light, I think modified versions of this could be employed in most circumstances. That said, in my northern, short growing season, I often prefer planting solanaceous crops in landscape fabric for the extra heat--it makes a difference.
Challenges	We're essentially planting into untilled ground - hard to see that working with mechanical transplanters. Fertility is key b/c of tie-up and reduced efficiency for N.	Our biggest challenge was sourcing mulch! Finding mulch that was compatible with our practices (organic, chem-free, etc.) in the volume and form that we need (the finer particle-size the better for even coverage and wind-resistance), without a bunch of weed seeds was hard for us. Cash isn't a great option, growing our own required equipment we didn't have, growing in place required time and equipment we didn't have (roller-crimper). Finding a good, steady, supply was tricky, but we have it now.
Key equipment	Rear discharge mower for living aisles; synthetic/organic mulch and systems for applying; hori hori and bulb auger for planting	We use our tractor to load our truck. The hand-crank conveyor is great, but not perfect. We use some nice pitchforks and rakes as well. In areas where the weeds got away from us, to step down weeds I've used a fence post on a rope, that worked pretty well. Landscape fabric is really helpful for us.
Second low/no-till production method		
Description	I call this system I LUV RYE. We don't have consistent access to a crimper, but I am a firm believer that crimped or mowed rye can work with proper fertility. The labor tradeoff can be worth even up to a ~20% yield drag for me because we are not particularly space constrained and size of veg isn't a dealbreaker (note that a big part of the yield drag is often stunting). We establish by early October at 4bu/acre and crimp or mow at anthesis. Do not rely on a *meh* stand of rye - add supplementary organic or synthetic mulch if needed.	Our low-till method is landscape fabric. We buy 12' wide by 300' long rolls. Using a blow torch we cut them into 100' lengths. The 12' width allows for 2 4-foot bed tops, and 2 2-foot pathways in the bed, path, bed, path fashion. We use earth staples to hold it down, but they're worthless until they get a bit rusty and connect to the ground, so we also use a ton of sandbags. We have sheet-metal jigs that I had made to my specs at a local machine shop, we use these to burn holes for planting into the bed-tops. We have 6-inch spacing all the way to 18-inch spacing, all triangulated for highest efficiency. - In the winter, we've typically fed our sheep and goat herd on these areas for them to poop and pee and waste their hay as they will. In the spring we till this under. After tilling, we lay out the fabric, staple it down, throw tons of sandbags over it, and convince ourselves it will never fly away in the spring storms. We then plant into the pre-burned holes with our stand-up transplanters, or by hand, if need be.

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Second low/no-till production method, continued		
Description, continued	One of my favorite things is that the soil health the next year is incredible if not tilling and we will often top dress ferts and staple landscape fabric right over the prior year's rye and plant solanaceous crops. We do this on a field/block scale, not on raised beds (yet), so a rotation might look something like rye based NT > solanaceous crop in fabric > tillage and bed building for early direct seeded crop > 2 more years of NT transplanting, tho it depends on if it's a tunnel or field.	In this method the beds and paths are totally covered, and usually the only weeding is right around the young plants in their holes, and usually a couple weeding rounds will get the crops large enough to shade out any more volunteers. The fabric is rated for 15 years, it's UV stabilized, and woven--so water and air can reach the soil, unlike plastic films. We've always had good results with both drip on top and overhead water.
Used for the following crops/crop families:	Cucurbits, brassicas.	Anything heat loving--like all our solanaceous crops, but also anything that is desperate to be planted when we run out of time. Or anything with low, basal rosettes like lettuce and some flowers. We also use it for direct seeding squash, melons, sunflowers, corn, and pumpkins.
Favorite features	Weed control, nicer to work in except planting, soil health the next year.	- It's fast, effective, and less labor intensive than prepping new notill beds. We often use this as our catch all method when we feel overwhelmed in June by all the things still not planted, especially when the choice comes down to prepping no-till beds vs. just stretching out another sheet of fabric. - Heat loving crops love the boost. - I also really like to use it for greens and lettuce, which seems counterintuitive due to the heat, but salanova does GREAT in it, choi, napa, etc.
Key considerations	Access to planting and termination equipment. The rye is your cash crop. You can't just surface broadcast it, it needs to go into a nice seedbed and germinate evenly. It will tie up loads of N. We calculate in an N deficit, adding ~40-60#/acre more than we normally would, top dressed near transplants.	WIND. A whole day worth of fabric laying can be upended by a stiff breeze. In some locations it may just be impossible. Or a whole row of something can be lost if the fabric blows up and on top of young seedlings on a hot day. We've had good results with sandbags, though they can be a bear to haul around. Considering how you lap your joints and the direction of your main seasonal wind currents can help as well. Get the widest fabric available that would fit your preferred system to limit seams.
Challenges	Fertility, weed control (it's great for weed control, but if it isn't adequate management takes more time/weed).	Landscape fabric isn't cheap, but oddly, I've found the best prices on Ebay. Small rodents LOVE it, and are so grateful that you covered over all their tunnels and offer them abundant cover from raptors all while supplying them with the tastiest snacks. Ground squirrels stole one whole winter squash, corn, and sunflower planting last year. Since burning is the best method for cutting, it may be tricky in in places with high fire risks.

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Second low/no-till production method, continued		
Key equipment	Options that fit your scale for planting, termination, fertigation. Raking seed into tilled ground can work but isn't as nice as drilling.	- The fabric. - Jig. You can burn by eye, but it's so much faster with a jig. - Blowtorch. We use a groovy extension handle on a regular map cylinder that makes it so you can stand up while using it. - Earth Staples, longer the better. - Sandbags and a load of sand. Cheap and effective
Future plans and recommendations		
What are your plans for future no/low-till production on your farm?	We are modifying a manure spreader for compost and woodchip application so we can move away from synthetic mulches and living mulch in aisles for some crops (b/c of creep into bed. We will still plant annual living mulches alongside direct seeded crops when we till in our cycle). I am hopeful that will enable us to direct seed crops into no till beds also but skeptical. I also hope this will improve N use efficiency but TBD, I'm worried it could actually reduce it.	We hope to keep converting a good chunk of our annual spaces to Notill, especially all the areas that are of irregular shape and length, as they don't play nicely with fabric anyway. We'll probably keep utilizing low-tillage and fabric for certain crops, but even in those zones, we've begun interrupting the low-till areas with no-till, perennial windbreaks. The low-till methods also offer a great way boost fertility while wintering our animals without having to shovel their poop to another location in the spring. So good.
What are the key transitional steps you'd recommend to farmers wanting to reduce tillage?	Start small and experiment, as people say, but also just go for it! Make sure you try it with crops that you can handle some yield drag or loss.	Listen to your land. No system I describe will work 100% beyond this place that I have worked with to arrive at these systems. Notill is about ending the antagonism between Nature and agriculture. We don't have to be battling weeds, or cracking genes, or inventing new chemicals, we can work with the world. It takes listening, it can be slow, and it requires us all to get comfy with making mistakes. I learned all of this by trial and error and a willingness to be curious while things are falling apart.
What pitfalls should farmers watch for when transitioning to low/no-till systems?	You have to remove plant residue if not tilling it in for disease and pest management, IMO. Depending on the disease and pest we sometimes even throw out the plant material or take it far away from fields or burn it. Think hard about your fertility management. Keep in mind yield drag might be stunting, not crop/plant failure. For some reason we have really struggled with cucumbers in any reduced tillage system I have tried.	When using a lot of mulch, you do have to be a little cautious about not binding up your nitrogen with all that carbon break-down, but if you're just surface applying, it should be okay because the ground will go at her own pace to break down the layers. Thinking no-till is a singular technique or a silver bullet. We can't just apply what others have done to our unique situations. I don't believe you can read a step-by-step manual and apply it your farm and expect the same outcomes across the board. I arrived at no-till on my farm because I was RESPONDING to what I was observing over years. No-till allowed me to be the most responsive and adaptive to the highly variable conditions I was seeing due to the early stages of the climate crisis. Being rigid or brittle in our thinking will not allow the kind of responsiveness that this moment in agriculture requires of us.

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Equipment list	LS MT468C Tractor with loader, 6' rural king rotovator, BCS 712 w/ 18" tiller, mechanical transplanter raised bed mulch layer, and soon a gehl 175 modified spreader.	Notill: - Mulch: We are currently using mushroom growing media from a local producer. The mix is weed-seed free, half composted, and full of mycelia when we get it. We've also used chopped hay. This is where your own creativity will be crucial. I've considered presprouting small square bales to kill the seeds, drying them, then running them through a bale chopper? - Landscape fabric for the pathways: we use DeWitt Sunbelt in 3' by 300' rolls for the paths, and 4' by 300' rolls for the end caps and perimeter paths. Again, I get ours off of Ebay. - Earth staples: we use 6 inch staples and get them off amazon from Sandbaggy. It's the best price we've found. Even our local landscape supplier is WAY more. You can get longer staples, we've just never wanted to afford them. - Wheelbarrow, rakes, shovels, etc. Or a truck and a hand crank conveyor belt--we got ours from Northern Tool, it was about $150.
Equipment list, continued		Lowtill: - Landscape fabric: DeWitt Sunbelt from Ebay. Each roll when we purchased them were about $75-$90 for the 3'-4' widths by 300' legths. The 12' widths are about $280. There are often volume discounts if you buy more rolls. Folded rolls are better for shipping prices for the wide ones. - Earth Staples, we get them through Amazon from Sandbaggy. - Sandbags we get from a local construction supply company, I think they're $60 for 200. We get sand from a local gravel company, it's cheap. - Goat and sheep: not required, but helpful. They're awesome, but really expensive, but you won't realize that until it's way too late. - A small tractor makes both low and notill easier, but can be done without. But we just use ours for tilling, and hauling heavy things like sandbags, or loading our truck with mulch.