No-Till Vegetable System at Tobacco Road Farm
by Bryan O'Hara

Over the last twenty plus years of intensive vegetable growing at Tobacco Road Farm in Lebanon, CT, we have constantly sought ways to improve the health and vitality of our crops and soils. Much of the land grows vegetable crops year round so the intensity of production demands very careful soil care. To this end, soil amendments, fertilizers, inoculants, and compost have been carefully selected and applied over the years in no small degree. Years of tillage, however, had left the fields with a soil structure that was lacking. To reduce tillage damage to soil, techniques and tools were introduced: chisel plowing with shallow roto-tilling, permanent wheel tracks, use of sweeps and points for primary tillage, increased use of cover crops, for examples. Even under this minimum tillage difficulties still presented themselves: poor soil structure with low fungal activity, low calcium levels and high nitrogen and high potassium in tissue analysis, weed proliferation-- especially galinsoga-- excessive soil drying during summer dry periods, along with some insect and disease pressure.

Measures to improve these conditions came through extensive soil and tissue analysis along with traditional Biodynamic approaches. The real push to no-till, however, came from the recommendations of Korean Natural Farming (KNF). Korean Natural Farming is most commonly known for the use and practices around IMOs, or Indigenous Micro-organisms. The practitioners of KNF, however, also recommend that no-till techniques be utilized. Some no-till practices have been used on the farm in the past such as seeding winter squash into a properly mown rye cover crop, or transplanting into heavily mulched soils, but it was clear that a much more versatile system would be needed for the intensive production of vegetables under complete no-till.

Over the last several years a system was developed on the farm which has proven to be quite successful. Ways to eliminate the preceding crops and chop their residues, achieve weed-free seed beds, control weeds, apply fertility, increase biological activity and diversity, seed appropriately, and allow for better interseeding of crop and cover crops were developed. The fields where this system was put into place were quite fertile, had few perennial weeds, and plenty of annual weeds. The various methods are still being fine tuned; but with a high level of success and it seems appropriate to share what has been done.

To begin, the first step is to chop the existing cover crop or vegetable residue if the vegetation is large enough to require this. This is achieved through mowing with a rotary mower front-mounted on a BCS two-wheel tractor. Essentially a heavy duty lawn mower, this machine has a bagging capacity which allows for the gathering of weed seed heads if this is required, though seed heads can also be removed with knives. This mower grinds the vegetation into small pieces for easy digestion into the soil and aids in the overall mulch layering effort to reduce weed seed germination, and weakens the root for better die-off. A sickle bar mower can also be mounted to the front of the BCS for mowing tall vegetation or for conditions where slower decomposition of residue may be required. Often we choose the sickle bar mower for a gentler mowing action to preserve beneficial organisms (spiders, lady beetles, etc.) Though we have quite a few larger tractors, the lighter weight of the BCS, along with superior maneuverability, have made it the machine of choice for this job. Other methods used to chop residue include hand tools such as the machete, scythe, or sickle. These tools need to be kept very sharp to be effective and are obviously much slower than the mowing machines, but occasionally have an appropriate use.

The next step after chopping the pre-existing vegetation is to eliminate the possibility of regrowth from its roots. From approximately May through September this is achieved through solarization with clear sheets of plastic in the hot sun. It is helpful to lay this plastic upon the recently mown residue because the roots are in a weakened state, and the plastic is secured with sandbags. Two days of sunny, roughly

75°F+ weather are usually sufficient but, depending on conditions, lower temperatures may work as well. The solarization quickly kills annuals, however perennial roots are entirely resistant to such quick solarization and are manually removed. The plastic is removed as soon as possible to avoid soil damage. It is often previously used high tunnel or low tunnel covers, though large sheets of 4 mil. construction plastic are also utilized. These sheets are rotated in order to cover large areas. For instance, we may mow a quarter acre of cover crop, solarize for 2 days, then mow the next quarter acre and move the sheets over. In this manner we can solarize an acre in eight days with a succession of plantings. During the cooler months these roots are hoed with very sharp hoes just below the soil line. In this case the roots are often simply vegetable residue, weak and easily hoed. Winterkilled cover crops such as oats and field peas are also utilized for early sown vegetables. Simply mulching over the roots with the weed-free compost and/or chopped mulch is also practiced. Occasionally young growth is flamed after rain or irrigation, and vinegar sprays have also been trialed.

Once the previous vegetation has been destroyed the next step is to apply weed-free compost, if required. The preparation of this compost is relatively easy as it is top dressed, which allows for much more flexibility in its state of decomposition. This compost goes a long way towards the burying of weed seeds and feeding the soil biology. The compost is prepared with high carbon materials, making it fungal friendly, and contains large amounts of silica as well as other added minerals. Biodynamic preparations are utilized. The basic ingredients are: cattle manure, weed-free farm residues, vegetable scraps from the local food co-op, spent hay, leaves, aged sawdust, woodchips, basalt dust (from a local quarry's washing pond), clay subsoil, and minerals like gypsum, hydrated lime, sea salt, sulfur, zinc sulfate and a very small amount of boron, molybdenum, and cobalt. The piles are turned a couple of times, then applied to the surface of the beds with wheelbarrows (loaded from a tractor bucket), a dump cart mounted on a Farmall Cub, or for wider beds straight from a pickup truck bed or a manure spreader which straddle the beds. Since the material is applied to the surface of the bed, larger volumes of carbon in various forms are possible and beneficial for our conditions. Compost application definitely gives better seed germination as most seed is broadcast, though it is not necessary at every seeding.

Following compost application, inoculant is often applied to the bed surface. This is in the form of an IMO, which is cultured from forest microbes from the farm's surroundings. The techniques are from Korean Natural Farming, manuals for which were purchased from Acres, USA. This inoculant looks like a mycelium rich compost and aids greatly in enhancing fungal and microbial activity. The compost and inoculant are very sensitive to drying and so should be carefully applied. Often this is late in the day, with immediate seeding, irrigation, and covering with mulch. The inoculant is also applied through irrigation and foliars. Sometimes inoculant is not applied at all, depending on the crop.

Seed is often broadcast over the bed surface. This needs to be done very carefully to get an even spread. It allows for maximum coverage of the bed with vegetation, which increases overall photosynthesis and thus helps feed the soil life and increase yield as well as inhibiting weed growth. Crops and cover crops can also be interseeded at any time since the soil surface is generally weed free. This allows for crop mix combinations which can enhance soil life as well as yield. This flexibility to seed cover crops into a weed free environment is very useful. Transplants are also set into the bed, though often they are set after the mulching step described below. Some crops are still seeded in rows. This is accomplished with the use of warren hoes or single tine hoes to rip a furrow through the mulch residue. Seeding can then be accomplished with a hand push seeder or placed by hand. This is often done for large seeded crops. The broadcast seed applied to the bed surface germinates better if it is worked into the soil surface. This is accomplished with the use of a drag, which is a group of chain rings attached to a bar similar to a chain harrow. The rings are grain drill covering rings, purchased from Agri-supply company, and were not expensive. The drag is pulled one way over the length of the bed and then back the other way and is very quick and effective. A rake can also be used but it is much more difficult to achieve similar results with

one. Another tool that is sometimes used for larger seed is a garden weasel, which resembles a hand pulled rolling cultivator. The garden weasel works the seed further into the soil before dragging. Also, a roller is sometimes employed, which further enhances seed to soil contact though often rolling occurs after the next step, mulching. The entire process of mowing to reseeding usually occurs in a matter of two or three days. This allows for higher yields and more soil coverage with a growing crop, thus enhancing soil biology.

Once the seed is worked into the soil, mulch is applied to cover the seed-- which aids seed germination, further reduces weed germination, and protects the compost and inoculant as well as provides food for the soil life. The mulch is chopped hay, straw, and/or leaves. These materials are run through a bale chopper to make a fine material that spreads easily and does not inhibit germination. Unchopped bales can also be carefully used. The hay is preferably from a late first cutting, which helps avoid some of the seed heads and is a more carbonaceous material. Straw is also used but needs to be free of grain and both of these materials need to be free of herbicide residue. Leaf is even better as a material as it contains virtually no weed seed, is more carbonaceous, and is most appropriate for feeding the soil. It is much harder to handle in bulk, however, and are easier to use when dry. Wet unground leaves have a tendency to mat which is not conducive to germination, though the use of partially decomposed leaves have been successful by themselves on some crops. Presently, a mixture of hay, straw, and leaf, with a little wood chip mixed in after grinding is the mulch of choice. Those materials should be applied in proper amounts to help cover seed-- less for small seeds, more for crops like potato. The mulch does cool the soil which is of benefit during the summer but may slow growth in the cooler months, so is sometimes not applied for winter production.

Immediately after seeding or planting, the crop is irrigated. This gives the crop a jump on any possible weeds and helps preserve the compost and inoculant. It is possible to irrigate before mulching-- significantly more water is needed to saturate and penetrate a dry mulch. Often this is the only irrigation necessary for a crop because of the tremendous benefit of no-till and mulching on soil water retention. If the crop requires additional fertilizing, liquid nutrient can be applied through irrigation. Specific composts are also used as sidedressing, and foliars are applied.

This system mostly buries weed seed, and with the layering techniques this control improves every year. Some weeds, however, still slip through and must be dealt with. Since the soil is mulched and crops are broadcast, hoeing is usually not an option. The tool of choice, then, is a serrated weed knife purchased from Johnny's Selected Seeds, though an aggressive steak knife can also work. They are used to cut annual weeds just below the soil line. For perennial weeds the roots must be removed, so they are either hand pulled or a trowel or drain spade is used for removal. If the weed has gone to seed it is removed from the field. The greatest difficulty for this system seems to lie in the potential for perennial weeds to build up, so attention is paid to removing them. Perennial weeds are generally not as fast growing as annual weeds, so offer less direct competition to a crop. Their strength, however, lies in their tenacity! Canada thistle, quack grass, and yellow dock are the most prominent weeds presently. In one area quack grass has required tillage. Perennial weeds are often intolerant of thorough, careful tillage, so the tillage equipment stands ready for action if required. In general, however, the soil structure has improved to such an extent that many of the roots are now able to be extracted simply by pulling on the plant.

Another potential difficulty is slugs, particularly for spring plantings. The high residue and wet conditions may encourage slugs, so irrigation is carefully applied so as not to keep the soil/mulch wet for extended periods. The chopped mulch may be dispensed with during this period. Techniques that keep the area drier, such as raised beds, proper drainage (tiles, ditches), solarizing larger areas, are useful. The lush growth from excess nitrogen fertilization also needs to be avoided. For problem areas, a slug repellent dust is applied to the surface at seeding. This is a mixture of approximately 40% talc

(magnesium silicate), 40% diatomaceous earth (calcium silicate) and 20% hydrated lyme. These materials are drying to slugs, and also enhance crop growth in our soils.

Overall the system has greatly improved the biological activity and diversity of soil organisms. Higher worm populations are obvious, as well as a much improved crumb structure to the soil. Fungal activity is obvious with lots of mycelium present, along with mushrooms. Vastly improved soil water characteristics include the great benefit of proper wicking from lower soil levels, which helps keep the soil life hydrated throughout the seasons, as well as better drainage, water retention, and in-soaking. Soil air is also enhanced through the ability of the soil to breathe through the crumb structure, while excess oxygenation from tillage is avoided. The soil structure is not pulverized through tillage, and erosion is decreased through mulching and constant vegetative cover. Theoretically there is better nutrient retention and management. There have been significant decreases in insects and diseases, including: greatly reduced brassica flea beetle, absence of root maggot in rutabaga and turnip, no cabbage losses to black rot, and much less leek leaf disease, among many others. Though a little more effort is required to prepare the beds and make the appropriate compost, overall there is great savings because of much higher yields, much less weed control, irrigation, and tillage requirements, as well as way less tractor time. So the iron is largely idle, and thus the system can be utilized by farms without mechanization. All of this has led to higher yields of higher quality. The crops are even sweeter and more flavorful, there are very few culls, storage quality is enhanced, and the vibrancy of the crops is noted and appreciated by the customers.

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