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**Transplanting Sweet Corn, a Case Study:
Jon Satz, Woods Market Garden, Brandon VT**

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Introduction. Sweet corn is an important crop for many diversified vegetable farms. Not only does farm-fresh corn attract consumers, but corn is useful as a rotation crop, too, because it hosts few insects and diseases that affect other vegetables.

Transplanting has the advantage of avoiding cold soil germination problems at the beginning of the growing season. The use of treated seed can help with cold-soil survival, but for organic growers that's not an option. Use of floating row covers also promotes growth in cold weather, and this technique can be combined with transplanting to further enhance stand establishment and earliness. Because weeds grow so fast under the row cover, setting transplants instead of direct seeding is particularly beneficial for growers that cover their corn but don't use herbicides.

Using transplants also helps assure a good stand, whereas direct seeding may leave gaps in the row. And, transplanting leads to earlier harvests, so you can attract (and keep) customers earlier in the season.

Obviously, using transplants costs more than direct seeding, so you need to weigh the pros and cons before trying it on a large scale. This case study describes the transplanting techniques used by Jon Satz, a grower in central Vermont who's helped pioneer the use of transplanting sweet corn. Some of his early knowledge about this technique was acquired through work funded by a Northeast SARE Farmer Grant in 2003.

Background. Jon Satz has owned and operated Wood's Market Garden since 2000, purchasing the business from retiring owners Bob and Sally Wood. For many decades the farm has been known far and wide for its retail sweet corn and strawberries. Jon converted the farm to certified organic practices and currently grows over 50 varieties of vegetables and fruits on 60 acres of sandy loam soils. Alongside the field production, he also has 7 greenhouses for bedding plants, ornamentals, and tomatoes.



Seeding. The process starts by seeding corn in a heated greenhouse. Initially, Jon seeded trays by hand, but that took too long so he built a drop seeder that sows a whole tray at once. Sweet corn seed is too large and heavy to work with vacuum seeders typically used to sow flats of smaller-seeded vegetables and flowers.

Jon's home-made seeder is a wooden box into which a transplant tray can slide. The top of the box is fitted with two plates that sit above the tray. The bottom plate can be made of metal, wood or Lexan Plexiglas, and it's drilled with $\frac{9}{16}$ inch holes in the same pattern as the cells of the growing tray being used. Above this slides a top plate of $\frac{3}{8}$ inch thick material (Lexan works very well and does not warp) drilled with $\frac{7}{16}$ -inch holes in the same pattern.



With the two plates offset at first, seed is poured on top. Generally, two seeds fall in each of the top plate's holes. Extra seed is swept off into a container for use later. Then the top plate is slid back so that the holes from both plates align and the seeds drop through to the growing tray below.



Seeds per cell. At one time Jon seeded one seed per cell. Now he prefers to double-seed each cell in a tray because that saves on the greenhouse space needed to grow the transplants, and the labor to raise them. The double-seeded plants are then set in the field at double the normal in-row spacing for single plants. "Simply put," he says, "it's twice as much labor from greenhouse to ground with a single-seeded cell tray, and probably not worth it. You may get a slightly larger ear but it won't bring a larger return since consumers are used to a smaller ear early in the season. Any ear size decrease with two seeds per cell is offset by the fact that when transplanting, a grower can choose main season varieties which have superior taste and larger ear size anyway. To me, a small ear of Mystique is still larger and tastier, and therefore more desirable, than a larger ear of Fleet. However, growers with a different type of market may not agree."

Potting Mix. To get a good root ball to develop, it's important to use a potting mix that's not too light, and not too dense. If using organic mixes, especially with smaller cell sizes, it helps to lighten with some peat moss to allow for a more cohesive root ball. Jon has had success using organically-approved compost-based potting soil blended 50/50 with a conventional peat-based potting mix. More recently he's been buying a conventional mix that has some compost in it.

Effect of cell size. Jon has tried various trays for transplanting corn. One year he got a Northeast SARE farmer grant to compare 162-cell and 98-cell trays (the 98 cell has about 70% more soil volume per cell). After about one week of growth in the greenhouse, he found that the primary roots of plants in the 98s were 6 to 8 inches long, with many fine lateral roots. The plants from the 162s had roots only 3 to 5 inches long with few lateral roots.

When taken to the field, it was easier and faster to handle the larger transplants from the 98-cell trays. Likewise, these plants grew quicker after transplanting than the smaller transplants, keeping slightly more ahead of the weeds. That allowed for more aggressive cultivation to control weeds. However, in the end, there was no difference in yield between the different cell sizes.

Although larger size cells seem to promote transplant vigor, the downside is that they take up more greenhouse space. Jon now uses a 128-cell tray with 2-inch deep cells because it is a compromise that offers efficient use of greenhouse space as well as enough cell volume to grow two non-stunted transplants per cell. This size cell requires 82 trays per acre, so Jon sows about 85 to 90 trays to assure that there are plenty of plants. Jon has also used durable injection-molded plastic trays, such as Plastomer 150s (which are no longer available).

Greenhouse considerations. Growers need to keep in mind the value of their greenhouse space when deciding whether to grow transplants, and if so, using what size cell. Net returns from corn don't come close to those of greenhouse tomatoes or bedding plants, so you don't want to displace those crops. If space is limited, go with a smaller cell size. If extra room is available, perhaps along the edges of a tomato greenhouse, then consider larger cells for higher quality transplants.

It is important to have sufficient cell volume to allow development of a strong transplant, to avoid root constriction which can lead to stunted plants in the field, and to have a root ball that doesn't fall apart when transplanting.



It's very important that trays do not sit directly on the ground so that the corn roots do not root there. Set the trays up on tables or benches, or else an upside down 1020 trays set on the ground works well under the growing tray, as the roots will naturally be air pruned instead of growing into the ground surface.

If seedlings are grown on the ground, it is important to protect from rodents. Row covers are not enough for this. Traps are needed for better protection.

Growing the transplants. Jon advises: "No matter what size cell you use, grow the transplants under relatively warm conditions until they're big enough to pull out, and then give them several days of hardening. Typically, transplants are grown for 14 to 18 days, with the first 12 days or so at 65+ degrees during the day and about 60+ degrees at night. If weather is somewhat settled outside, transplants are then transferred outside to harden off. Especially with early May transplants, this hardening off stage is crucial. Limiting water also helps the seedlings stiffen up a bit to better stand handling at transplanting. The goal is get a full-grown seedling that is not root-bound. Letting the transplants get too old will result in stunted plants in the field."

Exactly when your seedlings are ready for transplanting will depend on the growing conditions in your greenhouse, as well as variety. More vigorous varieties, like Arrowhead and Temptation, are usually ready to be pulled out of the trays in 16 days, while less vigorous varieties such as Mystique or Kristine can take up to 20 days before the root ball will hold together. A cohesive root ball is a key factor for successful transplanting (more so with some types of transplanters than others, depending on the mechanism for grasping the plants).

In the field. Jon now uses a carousel type transplanter which allows for rapid field transplanting. He used to use a pocket type transplanter. Though sufficient, that type of planter demanded twice the labor. With either method, double-seeded cells are set at 16-inch spacing in the row. At 36-inch between-row spacing, this gives a population of 21,000 plants per acre. Be sure to provide adequate fertility to the transplants. Fertilizer should either be dropped in the rows before setting plants, applied in a band at transplanting, or as a liquid fertilizer if using a water wheel.



-up view of pairs of sweet corn transplants recently set out in the field 16-inches apart in 36-inch rows.

Immediately after transplanting Jon covers the seedlings with floating row cover. Row cover is then pulled aside after two or three weeks so the corn can be cultivated and sidedressed. Then the cover is reapplied for another couple of weeks.

In Jon's location, the first corn seeding is usually started in the greenhouse in mid-April and then transplanted into the field at the end of April. A second greenhouse seeding is made the last week of April and transplanted into the field around May 10th. On average, transplanting leads to a week in earliness over direct seeded corn under row cover, and a 2-week gain over simply direct seeding. He now does a third transplanting in early May which is not covered with row cover. This has helped offset occasionally cold and cloudy May weather, when corn does not pop right out of the ground due to cold soils. This third planting is done primarily to make cultivation quicker and easier, not necessarily to promote earliness.

It works. Yields have been consistent over the years with many varieties of transplanted corn, at 800 to 1,000 dozen per acre. Some varieties do not do well, and these are typically the ones that lack vigor as transplants in the greenhouse. The quality and uniformity of transplanted corn has also been excellent, with every plant making an ear.



For Jon, the economics of this system make sense, largely because of his retail marketing which allows him to recover the extra input costs. The added expense of producing transplants, including planting, is roughly \$750 an acre over and above the \$1,500 per acre for direct seeding corn and covering with row cover.

With the yields that have proven to result with transplanting, gross returns at the retail level can be as high as \$6,000 per acre.

Varieties. Jon has transplanted dozens of different sweet corn varieties over the years, and he offers the following observations. Start with several varieties that you like, and observe how well they grow in the greenhouse. Sow a test-planting in March, or at least a month before you'll need to seed for the field. You'll be surprised at how much the varieties can differ in their vigor as transplants. Go with the most vigorous varieties that germinate well and grow uniformly.

While some growers transplant early-season varieties like Fleet or Seneca Arrowhead to get even more earliness, Jon only plants a limited amount of these to grab the earliest sales. He prefers to transplant main season corn so that he comes on the market with more desirable varieties in terms of size and flavor. He believes this helps keep his customers coming back.

There's a wide range of opinion among growers about which varieties work best for transplanting, and most, like Jon, make changes from year to year, seeking the proper mix of days-to-maturity and characteristics their customers want. A few of the varieties that have done well for Jon are: Arrowhead and Trinity for earliest corn (65-68 day), Temptation and Sweet Rhythm for mid-season (72 day), then Kristine (76 days), which needs a couple of extra days as a seedling, and Montauk (79 day).

Recently, Jon has shifted to only using Trinity for early corn and then making multiple seedlings of Temptation to stagger the transplant and harvest dates. He found the other varieties lacked the uniformity of germination and rootball strength of Temptation. He strongly suggests trialing varieties for performance as transplants, keeping in mind that this cannot be determined by their performance in the field.