PRODUCTION

Production Models and Methods

The exact combination of crops that Laura and Adam grow varies from year to year, as they acquire favorites and learn which varieties are a match for their growing conditions and markets. An excerpt from their 2007 seed list (Table 3) hints at the complexity of a CSA operation – and the organizational skills needed to plan for and manage production. Laura and Adam obtain their seeds from varied sources, including Johnny's Selected Seeds, High Mowing Organic Seeds, Fedco Seeds, and Wild Garden Seed.

Field Production

Adam and Laura combine a bed system with succession planting for their field production. Bed planting allows for more intensive production than standard rows and also provides flexibility for growing a diverse variety of crops with different spacing needs. While rows are more efficient at a larger scale, such as at Gardens of Eagan, the bed system works well for the smaller scale of Loon Organics (Figure 23).

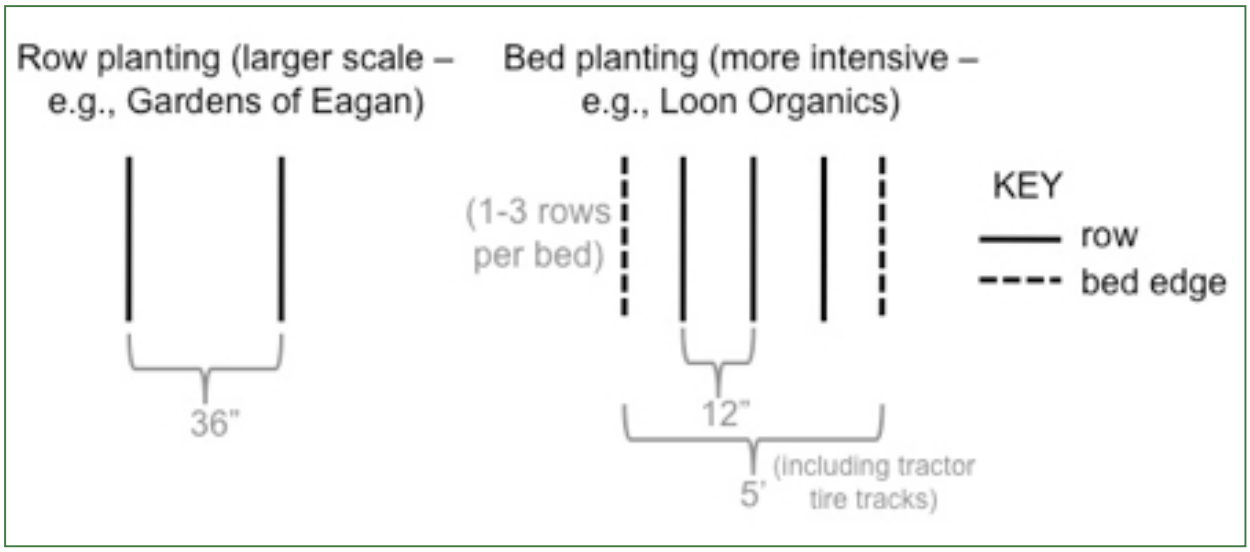


Figure 23: The production system at Loon Organics is based on beds that are 4' wide (or 5', including the tractor tires), allowing for more intensive farming than the standard row spacing used at Gardens of Eagan.

Table 3. Loon Organics' 2007 crop list

Category	Crop Type	# Varieties	Category	Crop Type	# Varieties
Allium	Leek	4	Herb (con't)	Sage	2
	Shallot	1		Thyme	1
Bean	Dry	1	Mustard	Arugula	2
	Green	3		Komatsuna	1
	Pole	1		Mibuna	1
	Purple	1		Mustard	3
	Wax	1	Onion	Bunching	1
Cucumber	Seedless	1		Cippolini	1
	Slicing	2		Red Storage	1
Eggplant	Globe	1		Sweet	1
Flower	Cosmos	1		Yellow Storage	1
	Nasturtium	1	Pea	Snap	3
	Snapdragon	1		Snow	2
	Sunflower	1	Pepper	Hot	3
	Zinnia	1		Sweet Bell	4
Garlic	Garlic	1		Sweet	10
Green	Arugula	1	Radish	Radish	4
	Beet/Chard Mix	1	Root	Beet	4
	Green Butter Lettuce	1		Carrot	4
	Kale	1		Hard Radish	1
	Lettuce	25		Kohlrabi	3
	Mustard	5		Parsnip	2
	Radicchio	2		Turnip	1
	Red Butter Lettuce	1	Squash, Summer	Patty Pan	1
	Spinach	2		Zucchini	3
	Swiss Chard	3	Squash, Winter	Acorn	1
Ground Cherry	Ground Cherry	1		Buttercup	1
	Heirloom Cherry	1		Butternut	1
Herb	Basil	5		Delicata	1
	Cilantro	3	Tomato	Cherry	4
	Dill	1		Heirloom	17
	Fennel	1		Heirloom Cherry	2
	Oregano	2		Heirloom Roma	1
	Parsley	2		Slicer	1

One of the keys to commercial production, whether in beds or rows, is matching row spacing to equipment for more efficient planting, cultivating, fertilizing, and harvesting. Laura and Adam have invested in tractor attachments that maintain consistent 12-inch spacing during seeding (Figure 24) and weeding (Figure 25).

Figure 24: This Planet Jr. seeder provides consistent spacing for crops that are sown directly into the ground.

The number of rows per bed varies by crop. Beets are an example of Adam and Laura's standard system of three rows per bed; beet production is described further in relation to Table 4 and under Crop Yields. Other crops, such as summer squash and certain greens, are planted in two rows per bed, using the outer two rows in each bed to attain a 24-inch spacing that works with the tractor implements. Tomatoes, watermelons, and cucumbers are unique in that they are planted in one (the central) row per bed. These heat-loving crops need good ventilation to prevent fungal disease; they also benefit from the use of plastic mulch, which heats up the soil earlier and minimizes soil splashing (and hence soil-borne pathogen transmission). Adam and Laura space the rows for the heat-loving crops at 10 feet to allow tractor passage for cultivation between rows.

Figure 25: This basket weeder maintains the same spacing as the seeder during cultivation for weeds.

Succession planting is critical to a CSA operation because it maximizes the period over which crops ripen and can be harvested, thereby providing customers with continuous product. Each crop has a different schedule of succession planting. There are two key factors that generally dictate the planting schedule.

1) Days to Maturity: For crops with a relatively short time between seeding (or transplanting) and harvest (i.e., 30-70 days) plus short harvest windows – such as salad greens, chard, cucumbers, summer squash, beets, beans, broccoli, cabbage, and cauliflower – Adam and Laura plant every 1-3 weeks to have a consistent supply throughout the season. Crops with longer maturity times (e.g., tomatoes, melons, eggplant, peppers, winter squash, onions) are planted in one or two large plantings in order to take advantage of the short harvest window that occurs in their USDA Plant Hardiness Zone. Longer-day crops must be in the ground by mid-June in order to mature in time (Figure 26). Although Adam and Laura are still learning about their farm's microclimate, the relatively flat topography means they have no major frost pockets to

deal with. They do use south-facing or south-sloping fields for earlier plantings and reserve other fields for crops that can tolerate some shade or other directional aspects.

2) Cold Tolerance vs. Frost Sensitivity: Because Adam and Laura plant a combination of cold-tolerant crops (e.g., broccoli, beets) and frost-sensitive crops (e.g., cucumbers, winter squash, melons), they must integrate the frequency of planting with the appropriate planting windows when planning production. Broccoli, for example, is transplanted successively every two weeks from May through July for harvest from early summer to late fall. Similarly, beets are one of the first crops planted in April or May, as soon as the ground can be worked. Beets are then planted every 2-3 weeks until late July. At Adam and Laura's location, frost-sensitive crops cannot be planted outside until late May, when the danger of frost has passed. Cucumbers are transplanted outside in late May and then planted every 3 weeks until mid-July for a continuous harvest. For crops with longer maturity times (i.e., 80-120 days), such as winter squash or watermelons, there are one or two large plantings in late May and early June to ensure that the plants have adequate time to mature before a fall killing frost.

Figure 26: Peppers, such as these Jimmy Nardello's Italian Sweet Frying Peppers (an heirloom variety and one of Laura and Adam's favorites), require a relatively long period to mature and so must be planted during a relatively short window.

Although Adam and Laura spend considerable time and effort scheduling their plantings, they inevitably have to make adjustments due to weather. They often plant earlier or later than planned once the season is underway. If germination of their first sowing of beets was delayed by a week, for example, and they were to do the second seeding a week after the first as originally scheduled, they would have both plantings come in at once and be overwhelmed with product.

Laura and Adam often plant different cultivars of the same crop together at the same time in order to achieve diversity in maturation dates and a diversity of plant characteristics, such as disease resistance. They select varieties that are best suited to production in certain seasons according to the yield quantities and the harvest windows they are targeting for each crop. Varietal selection, the bed system, and succession planting get integrated into a set of production details for each crop.

The sheer number of crops grown at Loon Organics makes it impossible to describe all the details of production here. Beet production from 2009 is summarized in Table 4 as an example of how the "when" and the "where" of the system come together for one crop (Figure 27). In the case of beets, four varieties were planted in four fields between April 28 and August 5, resulting in an almost continual harvest throughout the season. The table also shows how fertility, weed pressure, and irrigation are managed; these aspects of production are discussed further under Sustainable Practices, while the "audit trail" needed for organic certification is discussed at more length under Farm Management Operations. Below the table, Loon Organics' 2009 tomato crop is described in the sidebar as another example of how the bed system and succession planting are integrated; it also illustrates how their standard bed system is adapted for certain crops and how they integrate field and hoop house production.

Figure 27: Green-top beets provide a useful example throughout the case study because they illustrate Loon Organics' standard bed system and the use of succession planting to achieve product throughout the season. Laura and Adam also have continuous production data on beets because they have grown them consistently since start-up.

Table 4. Production log excerpts for 2009 green-top beet crop

FIELD PLANTING						SPRING COVER CROP			COMPOST			
Field #	Planting Date	Variety	Bed #	Row Feet	# of Rows	% Success	Type	Date Incorp-orated	Date Applied	Type (Source)	Rate	Method
1	28-Apr	A	6	100	3	n/a	none	n/a	10-May	Sustane (turkey)	20 lb/bed	sidedress
	10-May	A	7	100	3				25-May			
	25-May	A	8	100	3				15-Jun			
	25-Jul	A	9	100	3				n/a	none	n/a	sidedress
	5-Aug	A	10	100	3							
12*	13-Jun	A	1	300	1	80%	clover	15-Apr	5-Jul	Sustane (turkey)	40 lb/bed	sidedress
	13-Jun	B	1	300	1				5-Jul			
	20-Jun	C	2	300	1				12-Jul			
13	27-Jun	A	2	380	2.5	80%	clover	15-Apr	19-Jul	Sustane (turkey)	20 lb/bed	sidedress
		D	2	380	0.5							
		B	2	380	1							
9	5-Jul	A	5 & 6	300	5	80%	clover	15-Apr	1-Aug	Sustane (turkey)	20 lb/bed	sidedress
		B	6	300	1							

FIELD PLANTING			IRRIGATION						CULTIVATION		CROP INCORPORATION	
Field #	Planting Date	Variety	Source	1st Date	2nd Date	3rd Date	4th Date	5th Date	Basket Weeder Date	Wheel Hoe Date	Date/Method	Post-Tillage Type
1	28-Apr	A	sprinkler	3-May	10-May	25-May	9-Jun	16-Jun	mid-May	late May	late July, disced	field dug
	10-May	A		10-May	25-May	9-Jun	16-Jun	28-Jun	20-May	late May		field dug/chiseled
	25-May	A		25-May	9-Jun	16-Jun	28-Jun	n/a	15-Jun	late June		field dug
	25-Jul	A	drip	30-Aug	rain	n/a	n/a	n/a	late July	Aug	November, disced	field dug/chiseled
	5-Aug	A							late Aug	Sep		
12*	13-Jun	A	drip	20-Jun	27-Jun	*	n/a	n/a	late June	July	September, disced	field dug
	13-Jun	B							late June	July		
	20-Jun	C							mid-July	late July		
13	27-Jun	A	drip	27-Jun	8-Jul	20-Jul	n/a	n/a	mid-July	late July	October, disced	field dug
		D										
		B										
9	5-Jul	A	drip	5-Jul	20-Jul	rain	n/a	n/a	late July	Aug	November, disced	field dug
		B										field dug/chiseled

*Crop germinated, then in the middle of field growth was stunted (may have been due to nutrient imbalance); stopped watering.

NOTE: Pest pressure (type of pest, action taken) is normally recorded but none occurred with the 2009 beet crop.

At A Glance: Tomato Production

Laura and Adam seeded 24 tomato varieties in the greenhouse in 2009: 2 hoop house, 1 rootstock, 4 cherry, 1 heirloom cherry, 10 heirloom, 1 paste, and 5 slicer. They seeded two rounds about three weeks apart in early and late April, using open soil flats. Most varieties were started in groups of 25-50 seeds, with a few favorites seeded in quantities up to 250. They used heat mats for fast and even germination and achieved germination rates of near 100%. Seedlings were repotted in open flats (50 per flat) approximately 3 weeks after seeding date.

Five varieties were destined for transplanting in the hoop house in early June, while the remainder went to Field #2 (see Figure 48). Most field-transplanted varieties were in the ground by the third week in May, with the rest in by early June. In the tomato beds, Adam and Laura use 10 feet for between-row spacing (to fit their mower) and 2-3' for within-row spacing. Field tomatoes are trellised using the Florida basket-weave technique. Hoop house tomatoes are pruned to a single "leader" stem, and the stem is secured to twine with tomato trellis clips.

Field #2 had not been used by the previous landowners. Laura and Adam plowed the field in mid-April and used the field digger and drag to work out the oats and first flushes of weeds that covered the field and to break up soil clods. (Normally they would plow a new field the year before planting to allow a rest period due to their heavier soil, but the schedule was compressed the first season on their new farm.) In late May, they added a 3" x 3" application of composted cow manure as well as an application of Sustane 4-6-4 (at 25 lb per 300 row-feet) in the row centers just before transplanting the tomatoes They placed drip irrigation tape in the individual beds, covered the beds with a green plastic mulch approved for use by the Organic Materials Review Institute, and began transplanting (one row per bed as mentioned above) (Figure 28).

Adam and Laura used drip irrigation for Field #2 at planting times and again in mid-June and early July. The 2009 season was drier than normal until early August. Their soil type and some cooler than normal temperatures helped mitigate the drought to a certain degree. They cultivated weeds on June 20 and seeded a cover crop between tomato rows in early July. They chose Italian ryegrass as the cover crop and broadcast it at 50 lbs/acre. Germination of the rye was relatively low at 75% due to the drought, but it grew enough to be mowed twice between planting time and August.

The field tomatoes suffered from septoria leaf spot after early August rains (Figure 29). Although this fungal disease doesn't damage the fruit, the leaf damage leads to plant defoliation which in turn causes late-season tomatoes to be sun scalded. The disease cut short their harvest of saleable tomatoes by about two weeks, during the second half of September.

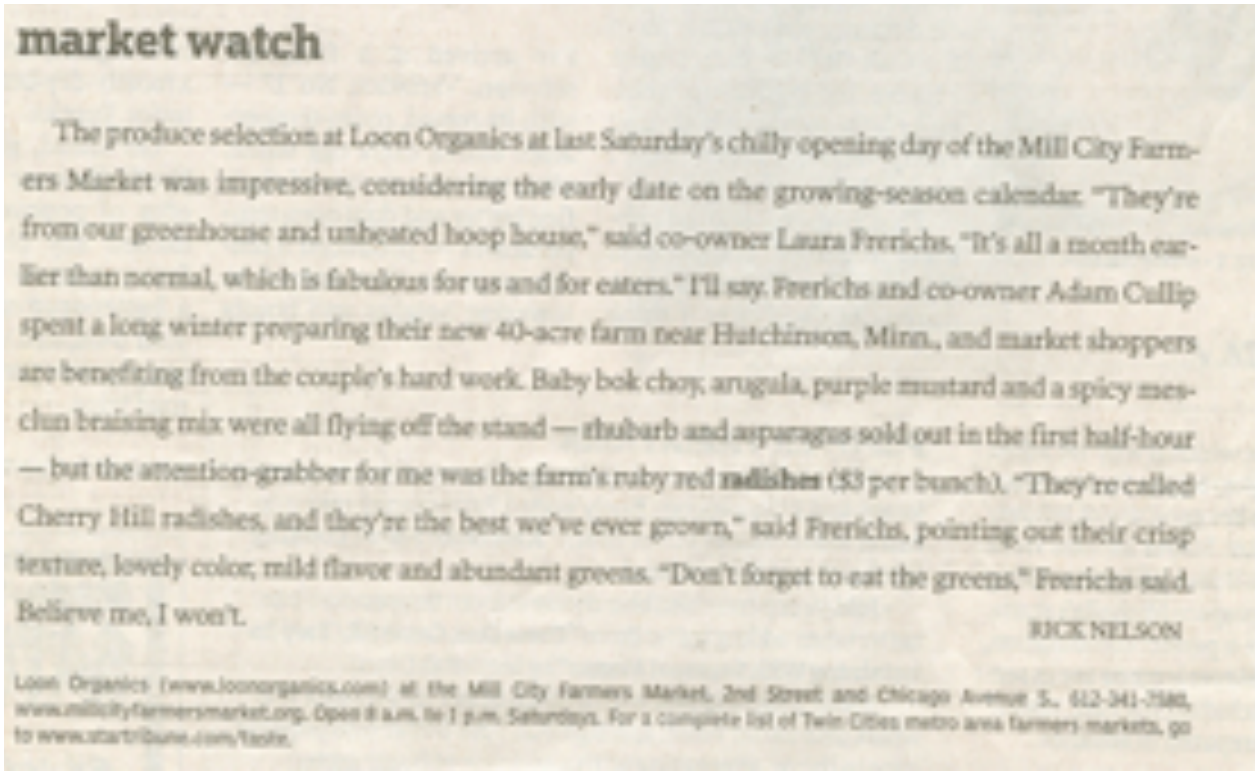
Figure 28: Tomatoes are planted on plastic mulch with 10' between rows.

Figure 29: Tomatoes are exposed to sun scald when the plants are defoliated.

Hoop House Production

As described under Infrastructure, Laura and Adam added a hoop house to their production system in 2009. Early in the season, they used it to grow radishes, bok choi, head lettuce, and other greens. They had product for sale at the farmers market by May 5, one month earlier than the same crops planted in the field (Figure 30). They appreciated the early income and jump-start it gave them on their season – as did their customers, including the food writer at the *Minneapolis Star Tribune* (Figure 31)!

Figure 30: Lettuce growing in the hoop house on May 5.



market watch

The produce selection at Loon Organics at last Saturday's chilly opening day of the Mill City Farmers Market was impressive, considering the early date on the growing-season calendar. "They're from our greenhouse and unheated hoop house," said co-owner Laura Frerichs. "It's all a month earlier than normal, which is fabulous for us and for eaters." I'll say. Frerichs and co-owner Adam Cullip spent a long winter preparing their new 40-acre farm near Hutchinson, Minn., and market shoppers are benefiting from the couple's hard work. Baby bok choy, arugula, purple mustard and a spicy mesclun braising mix were all flying off the stand — rhubarb and asparagus sold out in the first half-hour — but the attention-grabber for me was the farm's ruby red radishes ($3 per bunch). "They're called Cherry Hill radishes, and they're the best we've ever grown," said Frerichs, pointing out their crisp texture, lovely color, mild flavor and abundant greens. "Don't forget to eat the greens," Frerichs said. Believe me, I won't.

RICK NELSON

Loon Organics (www.loonorganics.com) at the Mill City Farmers Market, 2nd Street and Chicago Avenue S., 612-341-7580, www.millcityfarmersmarket.org. Open 8 a.m. to 1 p.m. Saturdays. For a complete list of Twin Cities metro area farmers markets, go to www.startribune.com/taste.

Figure 31: This newspaper piece sung the praises of Loon Organics' early-season produce and was accompanied by a large photo of bright red radishes, essentially providing Adam and Laura with a free 1/8-page advertisement in a major metropolitan paper.

After the early greens, they planted cherry and slicing tomatoes in the hoop house. They also did a companion planting of basil. Adam and Laura found that the hoop house helped prevent cracking in the vulnerable cherry tomatoes because they were able to control moisture levels. The plants were also healthier overall because rainfall was not causing soil to splash up onto the plants and transmit disease vectors as easily as in the field.

Figure 32: These trellised tomatoes grew well in the hoop house but required a lot of labor due to the trellising height, a factor Laura and Adam plan to adjust in subsequent seasons.

Overall Laura and Adam were pleased with their pilot hoop house and plan to add one or more over the next five years. They found 15' to be too high in the current hoop house because it increased the effort required to trellis and prune the tomatoes (Figure 32). In the future, they anticipate putting up gothic-style hoop houses that better manage snow load during the winter. Aside from experimenting with optimum hoop house size and refining management of day-to-day hoop house operation, they are still figuring out the best crop rotation for hoop house production in their situation. They would like to grow cucumbers and other crops in the additional hoop houses, but only a limited number of crop types do well in this setting.

Harvest, Handling, and Packing

Adam and Laura harvest most produce within the 24 hours prior to delivery. Most produce is harvested by hand, with the exception of some roots and potatoes which can be harvested with a root digger (Figure 33) or potato digger (Figure 34). They designate Monday, Wednesday, and Friday of each week during the growing season as harvest days. They use a daily harvest schedule that specifies the order in which crops are harvested, according to the crops' respiration rates and whether the crops should be handled wet or dry.

Figure 33: Loon Organics' root digger, shown in full view (top) and close up (bottom).

Figure 34: Loon Organics' potato digger.

Educator's Perspective: Resource Tip

Post-Harvest Handling and Packing

North Carolina State University has a series of fact sheets for post-harvest handling of specific crops and post-harvest cooling and handling technologies.

UC-Davis also has a comprehensive series of crop-specific post-harvest technology fact sheets.

A manual called Wholesale Success: A Farmer's Guide to Selling, Post Harvest Handling, and Packing Produce includes comprehensive sections on issues such as Building Relationships with Buyers, Food Safety, and Calculating Return on Investment. It also includes 63 crop profiles that give specific harvesting, cooling, storage, and packing information on most of the fruits and vegetables grown in the Midwest.

Requirements surrounding food safety plans have been hotly debated. Beginning farmers should educate themselves on current and proposed regulations by reading publications such as Food Safety on the Farm: Federal Programs and Selected Proposals.

Laura and Adam and their crew bring the produce from the field to the lean-to area for post-harvest handling. They use dunk tanks (Figure 35), cold well water, sprayer hoses (Figure 36), and/or a pressure washer to wash and cool produce before storage and a washing machine for spin-drying the baby greens. Tsunami 100, an EPA-registered, peroxyacetic acid-based, antimicrobial water additive, is used in the processing water. Laura and Adam store produce needing refrigeration in their large cooler. Shelves outside of the large cooler are used to hold tomatoes for ripening and storage.

CSA shares are pre-packed in ¾-bushel boxes and refrigerated on the farm until they are picked up by members or delivered to drop-off sites. In 2010, Laura and Adam plan to continue investing in upgrades to their packing area, adding more concrete flooring, drainage, a hand-washing sink with an instant hot water heater, and other smaller amenities.

Figure 35: Washing cauliflower after harvest.

Figure 36: Post-harvest spraying of beets.

Sustainable Practices

Laura and Adam follow organic principles, and challenged themselves to achieve organic certification, because they agree with the focus on soil building and soil conservation. While organic farming emphasizes soil health and other important aspects of environmental sustainability, they also believe that sustainable farming needs to address social and financial factors. They even throw in a fourth component, emotional sustainability, having recognized the importance of ensuring that the stressors of farming do not start to outweigh the benefits.

Adam and Laura would like to minimize off-farm inputs but know that overarching goals such as carbon neutrality are difficult to achieve with tractor-based farming. Their conversion of one gasoline tractor to electric, as described under Equipment, is a step in that direction. They hope eventually to incorporate solar energy generation into their farm.

Laura and Adam sought organic certification when they started out in 2005 for several reasons. As described in one of their articles from the New Farm, they considered both environmental and marketing factors. Their certifying agency is International Certification Services Inc. Figure 6 shows the boundaries of the areas on their new farm that they include in their certification plan. The areas include "hay" or "pasture" in addition to their tillable fields so they can convert currently unused land into vegetable production in the future and have it already certified as organic. As with production methods, the details of Laura and Adam's organic practices are too voluminous to reproduce here (their annual certification plan alone is over 30 pages). Below, however, are the basic elements of their approach to soil and fertility management and biodiversity.

Educator's Perspective: Resource Tip

Renewable Energy

Minnesota farmers can contact Clean Energy Resource Teams (CERTS) for technical resources for community-scale projects involving wind, biomass, biofuels, and solar power.

Nationally relevant resources are available from ATTRA.

Farmer's Perspective: On the Bookshelf

The New Organic Grower: A Master's Manual of Tools and Techniques for the Home and Market Gardener

By Eliot Coleman

With more than 45,000 sold since 1988, *The New Organic Grower* has become a modern classic. In this newly revised and expanded edition, master grower Eliot Coleman presents the simplest and most sustainable ways of growing top-quality organic vegetables. Coleman updates practical information on marketing, small-scale equipment, and farming and gardening for the long-term health of the soil.

Soils

Adam and Laura practice soil conservation by maintaining cover crops on steeper areas of the farm, adjusting field layouts to minimize soil erosion from rainfall, and using tillage practices that minimize soil compaction and disruption of soil structure. Although their tillage practices vary according to crop type, their standard approach is to prepare the ground in the spring by integrating the cover crop with a disc (Figure 37) and using a field digger (Figure 38) with a drag 1-2 weeks later. This sequence prepares the soil for planting, incorporates the cover crop, and works out the first flushes of spring weeds while still allowing some surface residue to remain.

Adam and Laura prefer to dig and drag at least two times before planting or transplanting, if time and weather permit. They avoid overworking the soil in general and always avoid working it when it's wet. Often, just field digging with a drag provides a clean and sufficiently even bed for seeding or transplanting. A chisel plow (Figure 39) is sometimes used in the fall for deep tillage, especially on fields where root crops will be planted the following year, but it still allows surface residues to remain. A moldboard plow (Figure 40) is used only to prepare ground that has been in hay for several years.

Educator's Perspective: Resource Tip

Equipment

Although organic vegetable farmers use machinery to different degrees, it helps to understand what options are available. Excerpts from an educational video called Vegetable Farmers and Their Weed Control Machines are now available on the eOrganic You Tube channel and include many of the implements, such as chisel plows and basket weeders, in use at Loon Organics.

Figure 37: A disc plow, or disc, uses one or more rows of concave discs to work the soil without turning it over completely.

Figure 38: Loon Organics' field digger.

Figure 39: A chisel plow accomplishes deep tillage without inverting the soil.

Figure 40: Loon Organics' three-bottom (or moldboard) plow, used for initial cultivation of fields to prepare for sowing or planting.

Figure 41: Though tempting to use often because of its positive short-term effects, Laura and Adam are trying to minimize use of the rototiller because of its negative long-term consequences on soil health.

When Laura and Adam started out, they used a rototiller (Figure 41) frequently because it made such nice seed beds. They quickly saw, however, that it had several negative effects: extreme compaction, destruction of organic matter and soil structure, hardpan below the surface, and increased noxious weed species such as quack grass and thistle. They are trying to get away from using a rototiller at all. They still use a walk-behind tiller to make raised beds in the hoop houses, and occasionally they will use the larger 6' rototiller with a tractor to prepare outdoor seed beds when the digger/drag method isn't effective. By rototilling only where needed to prepare for seed beds that must be very fine and even, such as for salad mix, they are minimizing disruption of soil structure.

Cover Crops

Laura and Adam use cover crops to control weeds, reduce erosion, build soil, and manage fertility. Some of their preferred cover crop species are hairy vetch, buckwheat (Figure 42), clover, oats, winter rye, ryegrass, and field peas. Eventually they hope to use chickens in some cover-cropped fields to help build fertility. Seeds are typically broadcast with a hand-broadcaster and then incorporated with a disc or drag.

Most years, Adam and Laura grow at least one cover crop on each field. Fields are typically seeded in the fall to an overwintered legume, such as vetch, and the cover crop is incorporated the following spring just before it blossoms in order to capture as much nitrogen in the soil as possible. They also utilize cover crops between the time when early crops are harvested and late crops are planted and during non-vegetable production years. Cover crop selection in resting years depends on weed pressure, previous crop history, and the fertility needs of a given field.

Figure 42: Buckwheat was planted as a cover crop in the unused portion of a field of spring greens. The fast-growing nature of buckwheat makes it good for weed suppression. It also provides pollinator habitat. This cover crop stayed in place until October, when it was incorporated into the soil with a disc.

Cover crops are also integrated with vegetable production. Fields of fall crops may be undersown with clover, vetch, or rye to build fertility for the next spring while still producing cash crops. For cover crops integrated with crop production, the timing and type of cover crops depend in part on whether a field is used for production until late fall (e.g., for fall broccoli and cauliflower) or is needed for very early spring planting (as is the case for onions and early potatoes). In some cases, the fall crop itself leaves enough residue to act as "cover" over the winter, thereby minimizing erosion and allowing for continual addition of organic matter to the soil.

Farmer's Perspective: On the Bookshelf

Managing Cover Crops Profitably, 3rd Edition

By SARE

Revised and updated in 2007, the 3rd edition includes a new chapter on brassicas and mustards, 16 farm profiles, and a comprehensive chapter on the use of cover crops in conservation tillage systems. Appendices include seed sources and a listing of cover crop experts.

Steel in the Field: A Farmer's Guide to Weed Management Tools

By Sustainable Agriculture Network/Edited by Greg Bowman

This SARE publication shows how today's implements and techniques can control weeds while reducing - or eliminating - herbicides. In practical language, it presents what farmers and researchers have learned in the last 20 years about cutting weed-control costs through improved cultivation tools, cover crops, and new cropping rotations.

Fertilizing

Laura and Adam use Sustane 4-6-4, a slow release nitrogen fertilizer made of composted turkey litter, on certain crops. They apply it at a rate of approximately 25 lbs per 300 row-feet to heavy feeding crops such as sweet corn, tomatoes, brassicas (e.g., cabbage, broccoli, cauliflower), head lettuce, melons, and cucumbers. They either incorporate the fertilizer into row centers at the time of transplanting or sidedress with fertilizer after transplanting. On their new farm, they also do some pre-planting applications of composted dairy manure to heavy feeding crops and as an amendment to supplement fertility levels in certain low-fertility areas. Application rates are generally 1-5 tons per acre depending on fertility needs. The timing of application depends on whether the manure is raw or composted. As with all aspects of their operation, Laura and Adam use substances and practices in accordance with the National Organic Program rules.

Regular soil tests are performed to figure out how many tons per acre of manure or compost are needed in each field and for each crop. Laura and Adam work with a soil scientist to determine the exact application rates and how best to capture and scavenge extra fertility through cover cropping.

Rotations

Adam and Laura's cover cropping and fertility practices are integrated into their crop rotation system. They try to maintain at least three years between the same crop families in a given location to prevent soil-borne disease and insect pressure. Although they are still learning about the complex relationship between fertility, cover cropping, and crop rotations and determining what works best for them, they currently have three basic rotations in use. An example of one of them is given in the sidebar. Numerous factors affect their decisions about which rotation to use on a given field, including ease of irrigation.

At A Glance: Crop Rotation

An example of one of Adam and Laura's three basic rotations is described below.

Year 1
Composted dairy manure is applied pre-planting at about 5-10 tons per acre to a specific field and disced in the spring. Early broccoli is planted in May and sidedressed two weeks later with Sustane 4-6-4 at 25 lbs per 300 row-feet. After the crop is harvested, oats and peas are planted in August for a fall cover crop. The oats and peas winterkill at the first hard frost and cover the soil for the winter.

Year 2
Green beans are grown with a fall cover crop of nitrogen-fixing hairy vetch.

Year 3
Peppers and eggplant are grown. Crop residue is mowed in the fall.

Year 4
Composted dairy manure is applied pre-planting at similar rates to Year 1 in preparation for planting cucumbers. Sustane is also applied at the standard rate. Cucumbers are planted on silver plastic mulch, and rye grass/red clover are seeded between the rows as a living mulch. After cucumber harvest, the red clover is allowed to continue growing throughout the fall.

Year 5
Red clover remains on the field as a cover crop/green manure.

Another example of crop rotation is available from Riverbend Farm, one of the farms where Laura gained farming experience.

Irrigation

Laura and Adam use both drip irrigation and sprinkler irrigation. Their water sources are the farm's well and the irrigation pond (Figure 43). Both water sources are tested each year for pathogens and nitrates as required for organic certification.

Figure 43: Loon Organics' irrigation pond, shown with the pump they purchased from the previous owners.

Biodiversity

In addition to the attention given to soil husbandry, Adam and Laura take an ecological approach to managing their farm. They have at least 15 acres dedicated to wooded areas, wetlands, and perennial grasses. Thus they promote biodiversity not just by growing a large number of different crop types but also by allocating part of their land to wildlife habitat. Their farming practices also foster biodiversity, especially among pollinators. Herbs are left to flower, a flower garden is maintained (Figure 44), and broad-spectrum biological insecticides are avoided.

Figure 44: Adam and Laura's flower garden provides pollinator habitat for the farm and free "pick-your-own``' flowers to CSA members whenever they pick up their shares or visit the farm.

Crop Yields

Adam and Laura track crop yields through the invoices for their different enterprises – CSA, farmers market, and wholesale. Beets and spring mix (Figure 45) were selected as examples of crop yields because of the patterns they illustrate.

Figure 46 shows yields per tenth acre for the three enterprises combined from 2005 to 2008. Acreages per crop type for all crops generally ranged from 0.05 to 0.2 acres while Laura and Adam rented land.

Adam and Laura attribute the steady increase in beet yield during their first four years of farming to improved efficiency as their knowledge level grew. Many of their crops show similar increases over the same period. Other crops, such as spring mix, show more variability through time. Spring mix yield dropped in 2007 due to drought, then decreased further in 2008 due to weed pressure. Weed pressure increased that year because they were growing spring mix in a new location that resulted from crop rotation, but the weed issues were exacerbated because Laura and Adam were at maximum production on their rented land in 2008. They ran out of time to keep the weeds under control, and once the weed pressure reached a certain threshold it was no longer worth resolving to salvage the crop yield. Thus spring mix illustrates the variability that results from weather and other factors outside of the farmers' control, as well as the trade-offs that occur in managing a complex system like organic CSA production.

Educator's Perspective: Resource Tip

Crop Yields

Estimating crop yields is notoriously difficult because so many variables are involved. A simplified table of expected crop yields for vegetable crops is available as a starting point from The Midwest Vegetable Production Guide for Commercial Growers.

Another publication, though not currently available online, has hard-to-find information about CSA planning such as how much crop to plant for a certain number of members. The *Iowa Community Supported Agriculture Resource Guide for Producers and Organizers*, published in 1997, can be ordered from the Iowa State University Extension Online Store (Publication number PM-1694).

Figure 45: Adam washing spring mix, which is a combination of salad greens that vary depending on the season.

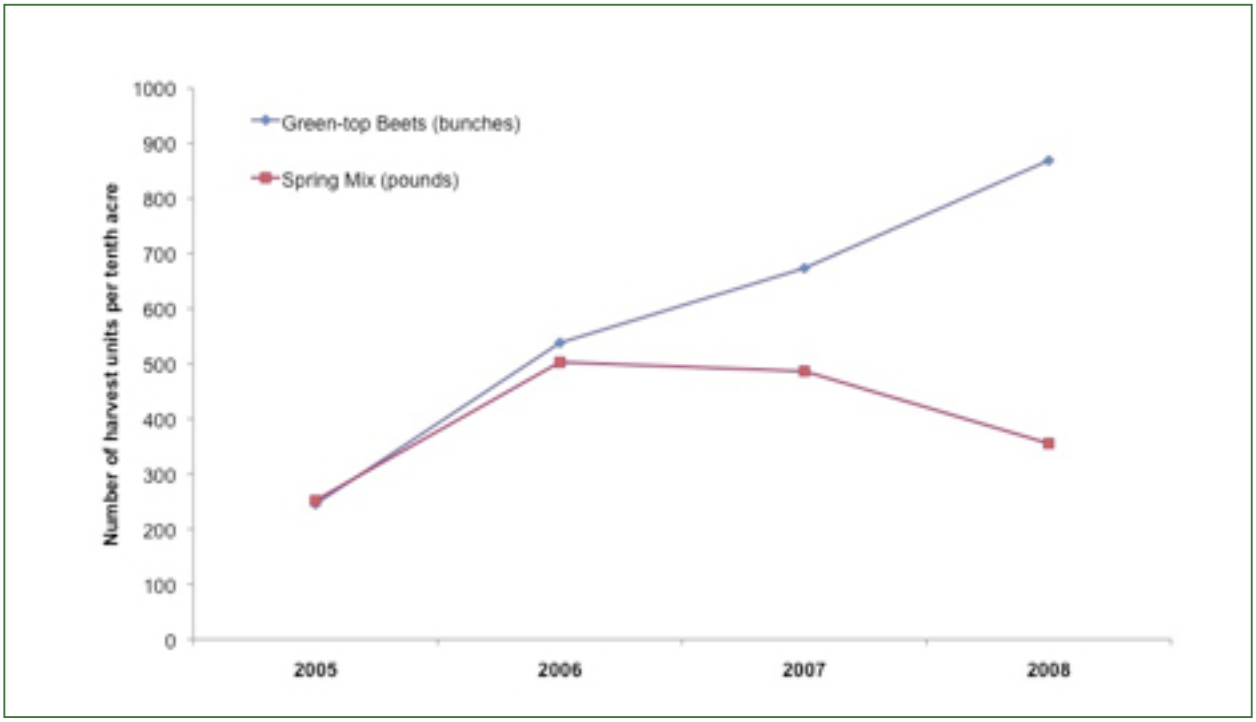


Figure 46: Yields for two Loon Organics products demonstrate the variable trends that different crops can follow.