Develop a Transplant Production Action Plan!!!

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What is an Action Plan? A detailed set of steps to accomplish a goal. The steps of what to do include who is responsible for doing them and a place to note when the action was done.

GOAL: Increase the production and purchasing of local, fresh, diverse vegetables to provide good food, jobs, and to improve the local economy and personal health .

What vegetable crops from transplants?

- Alliums: onions, leeks, scallions
- Brassicas: cabbage, cauliflower, broccoli, Brussels sprouts
- Leafy salad greens: lettuce head, lettuce romaine, lettuce buttercrunch, spinach
- Leafy cooking greens: chard, collards, kale, mustard, spinach
- Warm season fruit: tomato, eggplant, peppers, tomatillo
- Warm season cucurbits: cucumber, melons, summer squash, winter squash
- Herbs: parsley, basil, cilantro
- Sweet potato slips

Why use transplants?

- Allow selection of the strongest seedlings for growing on;
- Shorten crop field time, which allows earlier marketing and production of longer season crops in northern areas with short field seasons (season extension);
- Shorten crop field time, which allows more time for soil management and building soil organic matter with cover crops and green manures;
- Provide a very uniform plant density which helps provide more predictable yields;
- Allow a larger plant to survive predation by insects, give a head start in the field;
- Provide uniform coverage and faster ground cover thereby reducing weeds;
- Have very uniform plant spacing to facilitate precision cultivation;
- Provide quick rotations and succession replanting so multiple harvests are possible;
- Provide more reliable harvest and predictable harvest dates throughout the season;
- Allow efficient use of seed resources since thinning is not required;

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A farmer may buy transplants because:

- Space for production is not available;
- Cost of heating fuel is too high for the number of plants needed;
- Time to do a good job is not available;
- New farmers learning field production may not be ready to also learn transplant production methods;
- A local transplant producer may be able to do a better job at a fair price;
- It is easier to buy small numbers of a larger variety of cultivars.

Transplants grown on farm allow the farmer to:

- Concentrate the effort related to starting plants to occur in a small area;
- Obtain desired cultivars that may not be available to purchase;
- Obtain quality certified organic transplants that may not be available to purchase;
- Obtain transplants at times of the year when commercial transplants may not be available to purchase; four season farming requires transplants from January through October.
- Prevent introduction of potential insects or diseases to your farm from others;
- Generate an additional source of farm income if transplants are sold off farm;

Step 1: Would you rather buy transplants or grow your transplants? Which makes more sense economically? Which makes more sense given the time and space commitments?

If you want to buy transplants, consider these questions:

- Numbers: How many do you need and do you need specific varieties?
- Availability: Can you buy the transplants? And the quantity you need?
- Selection: Can you get the crops and varieties you want?
- Seeds: Can you buy the seeds and have the producer grow them?
- Timing: Can you get them when you want them?
- Quality: Can you get the size plant you want including the size of the roots?

Questions, Thoughts and Ideas:

- Where can a local farmer or gardener buy transplants? What if you need certified organic?
- Can you place an order or can you only purchase what they have?
- Are there enough farmers and gardeners that want to buy transplants to justify a farmer starting a local transplant business? Will other local farmers purchase transplants if quality plants are available?
- Can the farmers in the area develop a joint order early in the season and commit to purchase plants?
- One of the students from the MSU OFTP started a transplant business. One of the first steps she did was to develop order sheets and to offer specific varieties. Several former MSU students who are farming are buying her transplants. There are opportunities for more transplant production and sale.

If you want to grow transplants, what are the steps? A-B-C, 1-2-3, doe-ray-me, how hard can it be?

Step 1: What types and how many?

- Crop selection is based on either personal or market preferences and efficient use of space.
- Plant spacing depends in part of soil fertility and water availability (closer with more fertility and water).
- Refer to planting guidelines in seed catalogs or production manuals.

Step 2: Place – Where will I grow them?

- Need warm temperatures (60 to 70^{o}F) and as much LIGHT as possible.
- Light shelves in the house, basement, or garage.
- Cold frames – ok for finishing transplants – is it warm enough for growing?
- Greenhouse - two key questions that impact whether you grow or buy transplants:
    - How much does the light shelves or greenhouse for growing cost?
    - How much does it cost to heat the growing area or greenhouse?

Step 3: Materials – What do I need to purchase to be able to grow transplants?

- Seeds
- Root Medium and or compost
- Containers and or soil blocking equipment
- Fertilizer and or compost

Step 4: Knowledge, experience and time - How am I going to grow them?

- Numbers (how many to grow?) – Relate to field area and plant spacing. What % extra?
- Size (what cell size is needed?) (50, 72, 98, 128, 200, ???)
- Schedule (when to grow them?)
- Fertilizer (how to provide the needed nutrients?)
- Pests (how to manage insects and diseases?)

Step 5: planting out in the field

- Schedule and timing – see schedule template
- Spacing – see table values and Depth
- Management – early irrigation and fertility; protection from wind or frost if needed.

1. How many Transplants?

- Determine the garden or field growing space available.
- Develop a production or marketing plan.
- Refer to seed catalog or production recommendations for spacing. Example plant spacing: head lettuce at 9"x9"; chard and kale at 14" x 14"; pepper and eggplant at 24" x 24" or 18" x 30"; tomato 24" x 48".
- Make a planting map or layout and estimate plant numbers; increase by 10 to 20% for extras.

Some Sources of Organic Seeds, Cuttings and Plants:

- Johnny's Selected Seeds, 207-437-4395, www.johnnyseeds.com
- Richter's Herbs, 905-640-6677, www.richters.com
- Cook's Garden, 800-457-9703, www.cooksgarden.com
- High Mowing Seeds 802-472-6174 www.highmowingseeds.com
- Territorial Seed Company, 800-626-0866 www.territorialseed.com
- Fedco Seeds, PO Box 520, Waterville, ME 04703 www.fedcoseeds.com
- Seeds of Change, 1-888,762-7333, www.seedsofchange.com
- Baker Creek 417-924-8917 www.rareseeds.com
- Seed Savers Exchange 563-382-5990 www.seedsavers.org
- Bountiful Gardens 417-924-8917 www.bountifulgardens.org
- Harris Seeds 800-544-7938 www.growers.harrisseeds.com

Seed Storage Summary:

- When you invest in seeds, treat them like gold from the day of arrival.
- A seed storage protocol needs to be well established.
- Date all packets with permanent marker on arrival.
- Low temperature and moisture are needed:
  - Temperatures of 40 F or less (like a refrigerator).
  - Relative humidity (RH) of 40% or less (25 to 30% is ideal) (sealed in containers).
  - Total of temperature (F) + RH (%) = less than 100.
- Temperature (10 F less can double life)
- Seed Moisture (1% less seed moisture can double life)
- Avoid fluctuating (up and down) temperature and moisture
- Species recommendations are available (determine how much to buy) – learn which species store for several years (tomato) and which are best used the first year (onions).

Example cell Size and crop time from MSU Student Organic Farm

Cell Size	Crops	Weeks of Crop Time
128 cell flat	lettuce, kale, kohlrabi, cabbage, broccoli, cauliflower, collard celery, celeriac, pac choi, tatsoi, parsley, basil	4
20-row to 128 cell flat	Chard	5-6
20-row to 128 cell to 72 cell flat	pepper, eggplant	6-10
20-rows to 128 to 50 cell flat	Tomato	6-10
Mostly 128, some 200 to 128	Cut flowers	Varies – 6-12
50 cell flats	squash, cucumber, beans	3-4
Open flats with no cells	onions, leeks, scallions	8-12

Where to purchase plastic flats in quantity?

A list of plastic plug tray and flat providers in available on page 13 and 14 of the ATTRA Plug and Transplant publication. http://attra.org/attra-pub/PDF/plugs.pdf

In Michigan, Ohio and the Midwest some suppliers of plastic flats include:

- Blackmore Company in Belleville, MI – www.blackmoreco.com
- BFG Greenhouse Supply – 14 locations, 3 in MI
  - http://www.bfgsupply.com/content/
  - BFG is a distributor for the following plug tray and flat manufacturers:
    - Dillen Products - http://www.dillen.com/ ;
    - Landmark Plastics - http://www.landmarkplastic.com/
    - T.O. Plastics - http://www.toplastics.com/
- Waldo's and Associates – Ohio - http://www.waldoinc.com/
- Growing Systems, Inc - http://www.growingsystemsinc.com/

Root media – where to purchase or how to make?

- Any of the companies listed above that cell growing containers may sell seed starting media, peat, etc.
- Morgan's Composting – Dairy Doo http://www.dairydoo.com/Morgan_Composting/Home.html 4353 U.S. 10, Sears, MI 49679, phone: (231) 734-2451
- Michigan Grower Products http://www.surefill.com/Home.aspx 251 McCollum, Galesburg, MI 49053 Phone: 269-665-7071

Compost is a valuable addition to the growing medium and depending on the type of compost or fertility level, it can be used as 25%, 50% or even 75% of the growing medium.

- A key for transplant medium is to have mature compost. It should be at least 8 months old and preferably 12 to 16 months old. The compost needs to be stored to prevent leaching by rain.
- A good transplant medium compost can be made by mixing a bale of grass hay, a bale of alfalfa hay, a bale of wood shavings, a bale of straw, and a bale of peatmoss. Leaves are a great addition to the mixture and can be as much as 25% to 50% of the initial pile volume.
- Adding some soil, either loam or clay, even clay subsoil to the compost can increase nutrient retention and provide a positive effect on water holding during transplant production. Add the soil at the start so composting can kill the weed seeds present and nutrients are captured.
- If the materials are dry, as much as 100 gallons of water may need to be added. Bales can be soaked with water several hours ahead of making the pile. (about 5 gallons/ ¼ bale)
- A layered pile can be made using three pallets. The pile should heat to over 140^{o}F within a week. Mix the pile after the temperature decreases below 110^{o}F.
- When mature, this compost can be used at 50% by volume with either 50% peat (plus lime – 0.25 to 0.5 cup per cubic foot peat) or 25% peat and 25% vermiculite. The goal is to have available nutrients, a pH between 6.0 and 7.5, and a particle size that allows for good aeration and drainage of water.

Soil blocks can be made using specialized equipment to compress the medium into separate blocks that are placed in a wooden or plastic flat. Soil block media typically consists of 25 to 50% compost. Other components include peat, sand and perlite. Due to the compaction of the medium, more root medium is used than with other methods which helps provide more water and nutrient holding capacity. The following soil block medium recipe from the *New Organic Grower* has been widely published:

Component	Units or Ratio	Example Actual Volumes
Sphagnum peat (brown)	30	30 quarts
Compost – well aged 12 to 18 months	20	20 quarts
Coarse sand or perlite	20	20 quarts
Soil	10	10 quarts
Base Fertilizer (phosphate,greensand, bloodmeal)	3/4th	3 cups
Lime	1/8th	½ cup

Options for providing fertilizer/nutrients during production?

- Adding slowly soluble nutrients such as a blend of equal volumes of rock phosphate, greensand and bloodmeal will provide a balanced, slow release material. (Rate: 14 lbs per cubic yard or 0.5 lb per cubic foot.)
- Adding Bradfield Alfalfa based fertilizer or other plant based fertilizers such as soybean meal. There is a rapid breakdown/decay period that must be completed prior to using the root medium for seed germination or transplants. In moist medium held at 60 to 70^{o}F the recommended time period is 1 to 2 weeks. Good results have been demonstrated with 10 to 20 lbs per cubic yard.
- Purchase water soluble fertilizer and use according to directions. A key is to not over-fertilize which will lead to rapid, soft growth that is more susceptible to insect infestation and disease infection. Fish emulsion or hydrolysate are organic options.
- Top dress the flats with dry, screened compost. For plant based compost, rates will be from 1 to 2 cups per standard flat. For manure composts or vermicompost, rates will be from 0.5 to 1 cup to start, possibly more. Sprinkle evenly over the top, perhaps with a sieve or colander.
    - Worm compost is a great option that can be purchased or made on farm as an alternative to fish emulsion or hydrolysate.

Production options that influence fertility management.

- Start small and transfer/transplant to a finishing container
    - germination medium can have few nutrients and second or finishing medium can have more nutrients to finish the crop. Germination requires very little fertilizer and there is less chance of damaging young roots with excess fertilizer.
    - Less space needed to start seeds, more time needed to transfer/transplant to new container.
- Sow and grow in one container
    - less time handling and moving, more growing space needed
    - greater emphasis on nutrients in the media
    - or have a plan for soluble fertilizer or topdressing with compost

Sowing Options – Handle the seeds efficiently.

To cover or not to cover? How deep to sow the seeds?

- The majority of seed species do not need to be covered for germination. A few species require an absence of light to germinate.
- How deep to sow seeds or how much to cover often is influenced by how moisture will be maintained. In a growth room or chamber where high humidity and high soil moisture are maintained, seeds often are not covered at all.
- If the seed germination will be in a greenhouse environment and subject to drying, covering the seeds will help provide a more uniform and higher moisture environment that will provide faster and more uniform germination.
- Planting depth is often related to the size or diameter of the seed. Very small seeds are not covered at all and larger seeds like cucumbers or corn may be .5 to .75 inch deep.

A seeder can be as simple as using the seed envelope or a piece of paper or index card with a fold to help with dropping single seeds in the desired location. A variety of hand held plastic seeders are available from Johnny's Selected Seeds and other suppliers.

http://www.johnnyseeds.com/catalog/search.aspx?scommand=search&search=seeder

There are several types of mechanical seeders available:

- Sliding plate seeders
- Sliding plate seeders with guide tubes
- Vacuum needle seeders
- Vacuum drum seeders
- Vacuum plate seeders

Pictures are available at the following web sites:
Blackmore Company: http://www.blackmoreco.com/
Video demonstrations: http://www.blackmoreco.com/movies/movies.html
For small scale, see the "Can-do-it" needle seeder http://www.blackmoreco.com/can-duit.html
Growing Systems, Inc http://www.growingsystemsinc.com/ or http://www.growingsystemsinc.com/seeder.htm
Seed E-Z Seeder Inc http://www.sezsdr.com/ or http://www.sezsdr.com/prod.htm
Speedy Seeder www.carolinagreenhouses.com

Managing Light and Temperature:

Transplant Stages and Growing Conditions

Stage	Seed Germination
1	Sowing to radical (root) emergence
2	Radical to expansion of cotyledon leaves
3	Primary growth of leaves and roots – longest time
4	Finishing or hardening off before transplanting

Condition	Stage 1	Stage 2	Stage 3	Stage 4
Light	**Increasing** from darkness or 50 foot candles (fc) to up to 4000 to 6000 fc and eventually full summer sun (10,000 fc); Fluorescent lights provide 200 to 400 footcandles if close to plants.			
Temperature	**Decreasing** from warm (75 degrees) for first week or until germinated; to moderate (65 to 70) for many plants for growing, to cool (45 to 55 degrees) for hardening off prior to going outside. The warmer temperatures for stage 1 are often not essential, but can dramatically accelerate germination (radical and hypocotyl emergence) and reduce total production time.			
Medium Moisture	**Decreasing** from very moist like a saturated sponge prior to germination to drying out as the roots develop. High initial soil moisture helps improve the uniformity of germination.			
Fertilizer	**Increasing** from low at sowing and germination to higher for growth and perhaps very high with addition of fertilizer just at transplanting into the field. Soluble fertility is usually measured by electrical conductivity or EC, with a starting range of 0.5 to 1.5 mS (1 medium:2 water dilution). EC does not usually go higher later in production, instead the frequency of application can increase. With organic systems based on biological nutrient release from compost, the EC will typically be low (<1.0 mS)			

Growing Options:

- Light Shelves: In a heated area such as a house, basement or garage, use shelves to hold seedling trays and have fluorescent lights 3 to 6 inches from the trays or tops of plants. Lights will provide some heat. If temperature is low (less than 65), enclose the light shelf in a chamber using wood, plastic or foam insulation board. Foam with a reflective foil will also reflect light into the chamber.
    - The most efficient, economical and readily available lighting system is four foot long fluorescent shop light fixtures ($10 to $25 each) with cool or warm white bulbs. Cool and warm white bulbs can also be mixed in the same fixture. Plant grow bulbs are more expensive and do not provide growth benefits to justify the additional cost.

- In a hoophouse, build a "room" or "chamber" enclosed in plastic to provide sunlight and to trap heat. An electric heater adjusted with a thermostat can keep the chamber warm or germination heating mats can be used on shelves to provide the warmth that is beneficial for early seed germination.

- Use a heated greenhouse, either a lean-to type structure on the south side of a building, or a free standing greenhouse to produce larger numbers of transplants.

Light Quantity determines the transplant quality

- In general, the more light, the better the quality of the transplants.
- The light quantity, also called the daily light integral (DLI) or light sum is determined by the intensity or brightness of the light (measured in footcandles) and the duration of the light (measured in hours).
- Low light intensity (less than 1000 footcandles) needs to be provided for longer times – 16 to 18 hours per day.
- High light intensity from sunlight (range of 2000 to 5000 footcandles) can provide adequate light in as little as 10 to 12 hours per day.
- Light intensity - can you see the shadow of your hand clearly (higher light) or only faintly (lower light) or not at all (not enough light)?

Temperature influences rate of development and quality:

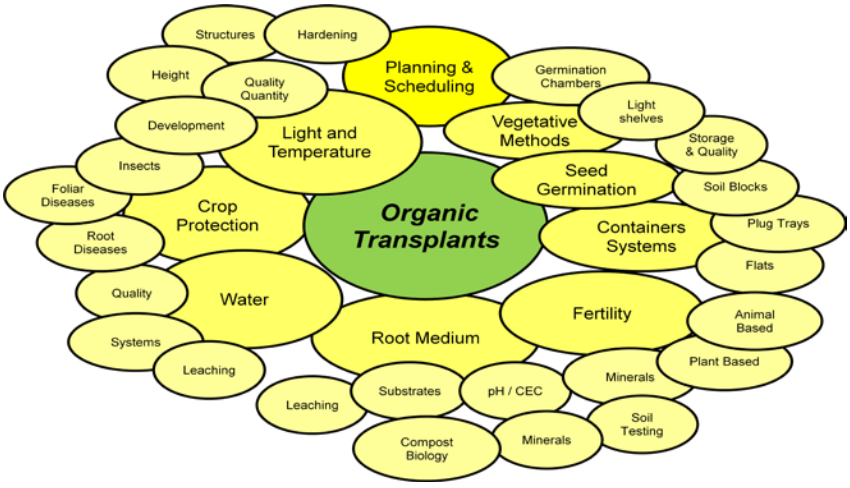
- The average daily temperature (ADT) or 24 hour average temperature influences the rate of development.
    - o High ADT (greater than 70) may lead to growth being too fast and plant leaves and stems being soft or weak.
    - o Moderate ADT (60 to 70F) can provide adequate growth and healthy plants.
    - o Cool ADT (50 to 60F) can be used to slow growth and prepare plant leaves and stems to survive outdoor conditions with wind and high light.
- High day temperatures combined with low night temperatures (positive difference or DIF) will lead to taller plants with weaker stems. Keeping the day and night temperature similar (zero difference or DIF) will lead to shorter plants with stronger stems.

How large should transplants be?

- Based on the available research, there does not seem to be an ideal transplant size. While in general larger is better, there is a point where a transplant that is too large will not have an adequate root system to supply the leaves with water.
- Rather than emphasizing size, a better measure of quality and success is the balance between root and top growth. With smaller containers and root balls, the top growth needs to not be excessive for the plant to survive the move to the field or garden.

Hardening Seedlings to Avoid Transplant Shock

If transplants will be going from a warm greenhouse to a cold outdoor environment, or from a lower light greenhouse to high light situation, or from regular high moisture to dry field conditions, it may be beneficial to harden the plants or slowly adapt them to the changing conditions. Transplants can be moved from the greenhouse to the outdoor environment or to cold frames several days or longer before actually planting out in the field or garden. The soil can also be dried out to allow some wilting of the transplants. Transplanting during cooler parts of the day, in cloudy weather, or when soils are moist or water can be applied, all help to minimize transplant shock.



Action Plan Template

TITLE:

PURPOSE:

PREPARED BY: **DATE PREPARED:**

Step	Procedure(s) (WHAT) (Action Required)	(WHO) Person Responsible	(WHEN) Week from Start	(WHEN) Calendar Week	Date Done
1					
2					
3					
4					
5					
6					
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8					
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Start Healthy Stay Healthy – Ten Tips for Tough Transplants

For many farmers and market gardeners, starting transplants signals the start of a new season. Onions and leeks start in early February; greens and brassicas start in early March. For hoophouse production, the first lettuce and greens transplants are seeded in early January and planted in early March. Hoophouse tomato, pepper and eggplant transplants are started in February for April plant dates. Greens and Brassicas are sown again in June and July for field and winter hoophouse production. At the MSU Student Organic Farm, transplant production will be continuous through September to supply the 48 week CSA program and farmstand. Following is a quick review of some keys to successful organic transplant production covered in the course taught at MSU and for the MSU Organic Farmer Training Program.

1. Start with quality ***seeds*** and protect seed vigor with proper storage at low temperature (<40-50F) like a refrigerator and low humidity (<40-50%) like in a sealed glass jar or plastic container.
2. Choose a ***system*** that works for you and the time available. Options include a) sowing in rows in open flats and pricking out to cells, b) sowing in small (200-400)cells and moving to larger (50-128) finishing cells, c) sowing in a larger (50-128) cell final tray, or d) using soil blocks. A major factor is how much heated space and labor are available for starting and finishing the transplants.
3. Pick the right size ***growing container*** or soil block with adequate space, drainage and root pruning. Examples are 200 cell trays for starting lettuce and Brassicas, 100 to 128 cell trays for finishing lettuce and Brassicas, and 50-100 cell trays for starting and finishing vine crops including cucumbers and squash. Generally deeper cells with more volume are preferred.
4. Invest in high quality ***root medium*** or carefully make your own. Peat, coir, perlite and vermiculite are suitable for organic certification. Mature, well made compost that includes mineral soil at 25% to 50% or root medium volume provides the necessary biology and helps maintain nutrients and pH. Soil test for pH, EC and macronutrients prior to sowing or do a bioassay by starting some seeds early.
5. All the ***fertility*** does not have to all be in the root medium at the start. Generally start fertility low and go up over time. Rock phosphate is slowly soluble and can be incorporated in the medium. Consider top dressing transplant flats with compost or worm castings (0.5 to 1 cup per tray or flat) as needed. An alternative is to make a water extract of the compost or worm castings to apply to flats.
6. The more ***light*** the better if you can keep the greenhouse cool. Light intensity together with adequate plant spacing helps prevent stem elongation. Many small scale farmers do not start seeds in a greenhouse. Germination can start in the dark but trays need to be in the light at emergence to prevent stretch. Fluorescent lamps close (3" to 6") to the plants or high pressure sodium lamps at a distance (4' to 6') will work. Keep increasing light before going to the field.
7. ***Temperature*** drives the rate of development but if too warm, quality is lost. Warm (70-75F) soil temperature is best at the start for rapid germination (a heat mat helps), with cool (60-65F) later and even cooler during hardening (50-55F). The difference between day and night temperatures (DIF) determines stem elongation. The bigger the difference the taller the plants.
8. ***Water*** uniformly and avoid leaching nutrients from the root medium. Start very moist to wet and reduce gradually. Watering from the bottom (subirrigation) may help once emergence is complete. Keep foliage dry at night. Once the root system is established, allow the root medium to dry between irrigations. If time allows, more frequent applications of less water will help manage height.
9. ***Protection and prevention*** are the best pest and disease strategies. Lower air temperatures reduce the rate of pest development. Adequate plant spacing, air movement and low relative humidity can stop development and spread of foliar diseases and also reduces stem elongation. Quality root medium and irrigation timing prevent root rots. A soapy water wash can manage most foliar pests.
10. As the transplant matures, soil moisture and air temperature go down, and light and fertility go up. Lowering temperature and increasing light and air movement are part of ***hardening*** and usually occurs by moving transplants outside for 5 to 10 days before field planting. Try to protect from leaching rainfall. If needed, add nutrients to flats a few days or a week prior to going to the field.

For a more information, check out www.hoophouse.msu.edu and the resources section.