



UNIVERSITY OF ILLINOIS
EXTENSION

**GROWING A NEW GENERATION
OF ILLINOIS FRUIT AND VEGETABLE FARMERS**

MARKET FARM TOOLS AND SYSTEMS

Zachary Grant

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Adapted from John Hendrickson

April 2015



Objectives:

- Capitalizing a Market Farm
- Capitalization Priorities
- The Front End of the Market Farm
- The Middle of the Market Farm
- The Back End of the Market Farm
- Concluding Thoughts and Questions

Estimated Equipment Needs for Various Sizes of Vegetable Farms.

	Seed Starting	Power Source and Tillage	Direct Seeding	Production Equipment	Cultivation	Harvesting	Postharvest Handling	Delivery
1-3 acres	small hoop house, grow lights, planting trays	rototiller or walking tractor, custom work	Earth-way seeder, Cyclone seeder	Back-pack sprayer, irrigation, tools	Wheel hoe, hand hoes, digging forks, spades	Field knives, hand boxes, buckets, carts	Bulk tank, canopy, packing containers	Pickup with topper or van
4-6 acres	1000 sq. ft. greenhouse, cold frames, field tunnels, planting trays	35-40 hp tractor, with creeper gear, power steering, high clearance	Planet Jr. plate seeder	1-row transplant er, irrigation, more tools	Cultivating tractor (IH Super A or IH 140)	Potato digger, bed lifter, wagon, more boxes, buckets	Roller track conveyor, hand carts, walk-in cooler	Cargo van



Market Gardening: A Start-up Guide

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=18>



Estimated Equipment Needs for Various Sizes of Vegetable Farms.

	Seed Starting	Power Source and Tillage	Direct Seeding	Production Equipment	Cultivation	Harvesting	Postharvest Handling	Delivery
7-10 acres	Additional cold frames, planting trays	40-60 hp tractor, chisel plow, spader	Stanhay precession belt seeder with belts	2-row transplanter, sprayer,	Tool bar implements : beet knives, basket weeder	More field crates	Barrel washer, spinner, pallet jack	1 ton truck with refrigeration
20 + acres	2,000 sq. ft. greenhouse	80 hp tractor with loader bucket and forks, compost spreader	Nibex or Monosem seeder	Irrigation, bed shaper, mulch layer	Sweeps (Besserides), Buddingh finger weeders, flame weeder, potato hiller, 2nd cultivating tractor	Asa lift, harvest wagon	Wash line, larger cooler, packing shed and loading dock	Refrigerated truck



Market Gardening: A Start-up Guide

<https://attra.ncat.org/attra-pub/summaries/summary.php?pub=18>



Start-up Capitalization Costs

- It is possible to get started with not much more than “a shovel, a rake, and a hoe”
- Ultimately, a wide range of tools and facilities are needed to grow and market effectively, profitably, and sustainably
- \$10,000 per acre



Where do I get my \$10,000???

- Don't quit your day/winter job
- Don't let your partner/spouse quit their job
- Acquire a rich, beneficent aunt or uncle
- Spread the \$10,000 over 3-5 years
- Scrounge, network, and get lucky
- High value cash crops
- Loans (USDA Microloans up to \$35K)
- Crowdsourcing (Kickstarter)



Goals, Priorities, and Decisions

- Set goals for yourself and your business and use them to guide priorities and decisions
- Visit other farms and talk to other growers
- Consider carefully the purchase of all equipment, tools, and implements:
 - Does it fit my scale? Does it fit the scale I want to reach?
 - What does it cost? What does it cost to operate? What is its resale value?
 - Is it durable? Can I repair it myself?
 - Is it easy to use? Is it enjoyable to use? Can others use it?
 - Is it sustainable?
 - Do I *need* it, or *want* it?
 - Does it fit within the context of my over-all farm plan?
- Emphasize the “back end” of your farm



The “Back End” of the Market Farm

- Harvest Aides
- Post Harvest Handling
- Storage
- Delivery
- Marketing/Sales



Harvest Cart

Original design by Dan Guenther, Common Harvest Farm
~\$200 - \$400?

Free plans available at: marketfarmtoolbox.com

A version is also being sold for \$350 by: avalonfarmshomegrown

All aluminum construction

Can haul lots of
produce, transplants,
hay bales, trellis posts,
etc.

Rolls easily





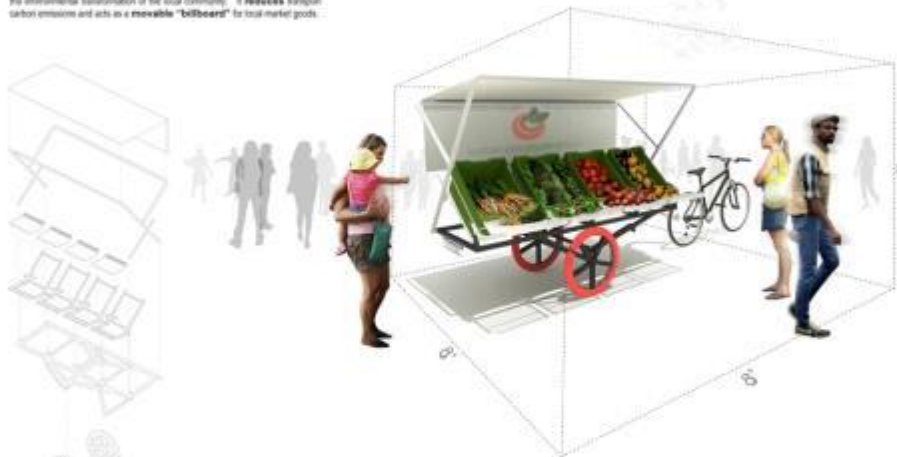
Folding FARM II

A Farm-to-Market Portable Produce Pavilion

Spring 2014

Folding Farm II (FFII) is a "green" produce transport vehicle and a deployable farm stand. It represents the modification of Folding Farm I (FFI; center above), a working prototype conceived in 2012 as a bicycle-covered delivery system and market display for locally grown and sold produce. The next generation (FFII), currently in development, decreases the weight and cost of the first prototype.

Folding Farm II is a farm utility vehicle that delivers and displays produce for local marketplaces. These added values supersede its additional cost. In addition, it becomes a deconstructable design idea that serves as a model for the environmental transformation of the local community. It reduces transport carbon emissions and acts as a movable "billboard" for local market goods.



Folding Farm II is constructed steel and aluminum sections. It incorporates standard plastic farm-grade vegetable bins, which means that the produce can be cleaned and immediately packaged on the farm, eliminating handling at the market.



Folding Farm





Harvest Bins at SSF



Mesh Bags

nylonnet.com



Greens Harvester

\$190 - \$210 Johnny's

www.johnnyseeds.com

877-564-6697

Available in 30" 42" and 48" widths

Must have smooth, clean, level beds

Works best with very solid stands of greens



Quick Cut Greens Harvester

One person can cut over 175 lb. per hour. Powered by a cordless drill, the harvester's 15" fixed and moving serrated blades make a smooth, clean cut. A rolling macramé brush pulls leaves into the blades and then throws them to the back of the basket.



\$495 Johnny's

www.johnnyseeds.com

877-564-6697

Must have smooth, clean, level beds



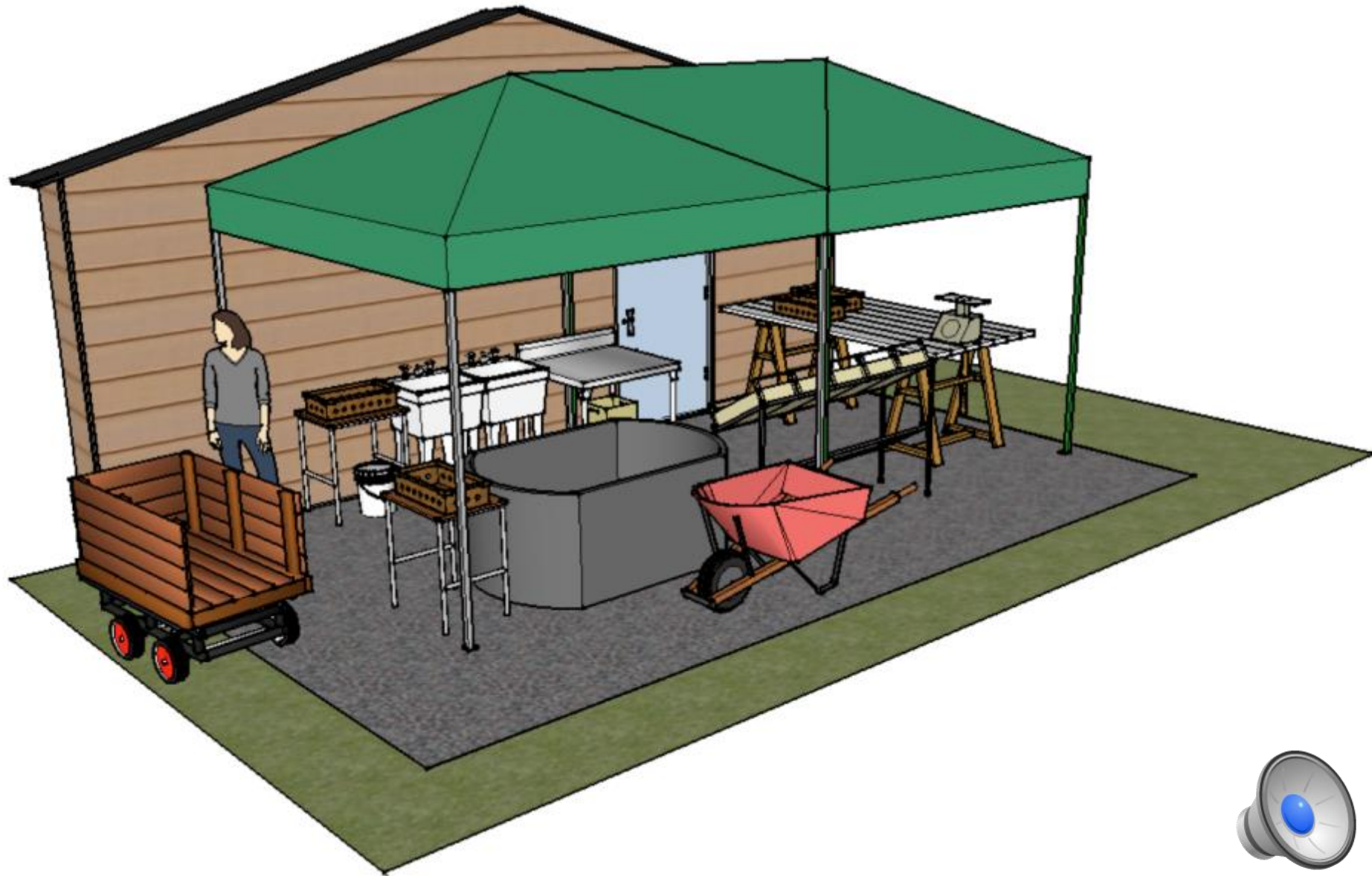
Washing and Packing Sheds



Washing and Packing Shed Basics

- A roof
- Ideally, enclosed or enclosable
- Access to clean water (ideally plumbed not via garden hoses)
- Provision for water drainage and waste removal
- Appropriate food contact surfaces
- Access to electricity (lights, equipment, etc.)
- Hand washing sink
- Storage for post-harvest tools and supplies
- Easy access to crop storage facilities
- NOT near cull/compost piles or animal facilities

Basic Washing and Packing Area



Wash Shed Example

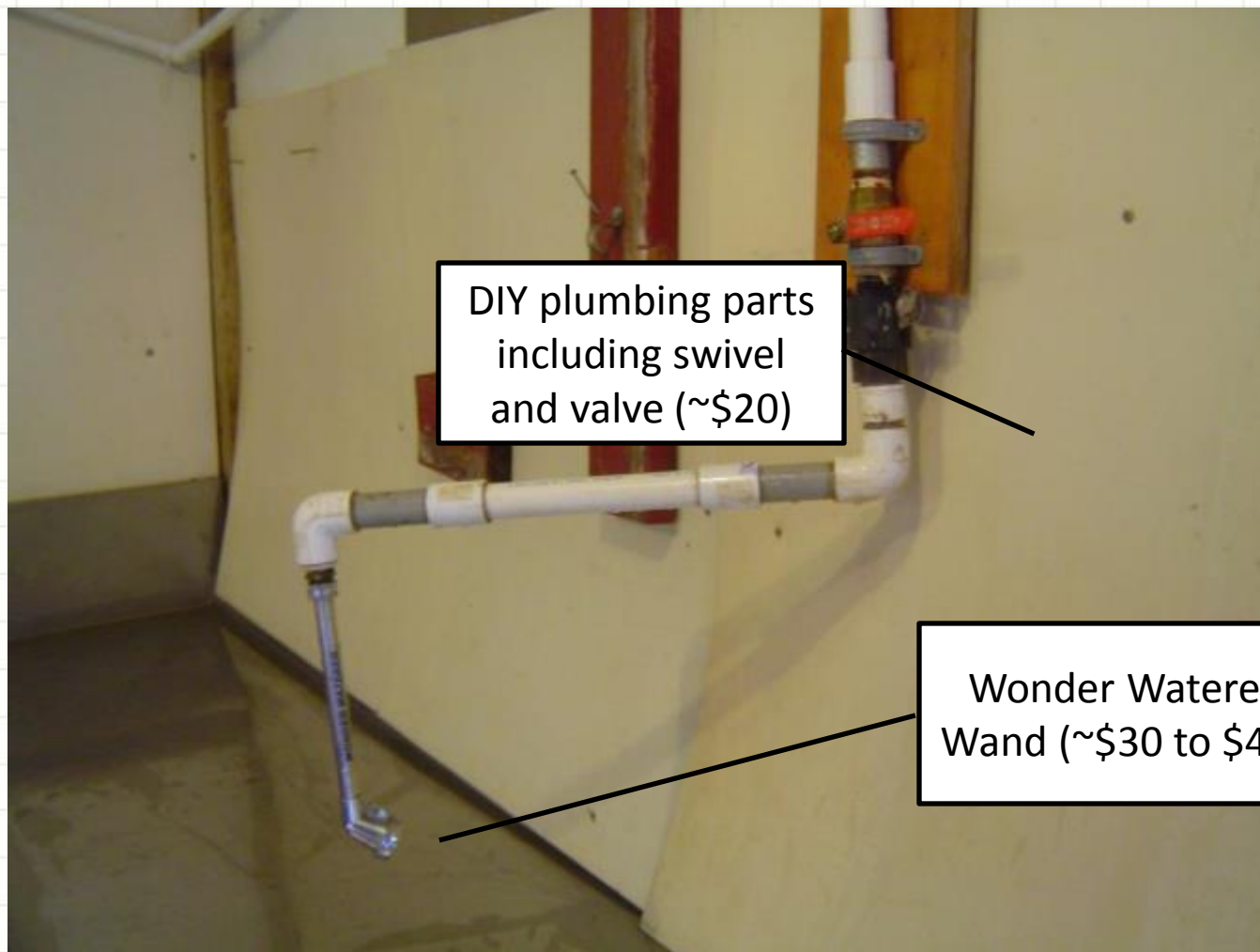


Plans for this wash area set up are available at:
www.leopold.iastate.edu/cool_tools/wash_stations





Hands Free Washer



SSF Wash/Pack





Wash Shed Example



In this farm's early years, the growers decided the easiest and quickest structure to build was a hoophouse that was then covered with shade cloth to serve as a washing and packing facility. They have since upgraded to a totally enclosed GAP-certified facility.



Walk-in Coolers

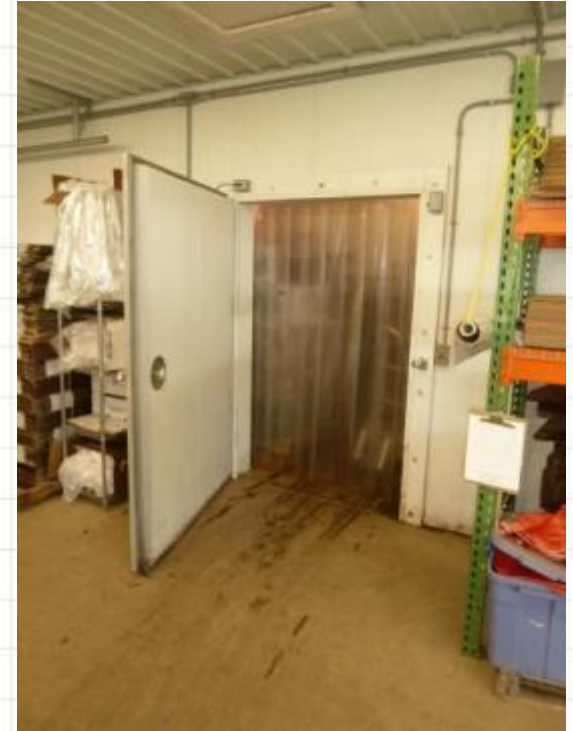
Anyone in the business of growing, marketing and delivering **fresh** produce needs to be able to cool produce and keep it cool prior to it being sold and delivered.

“Local” or “picked the same day” is not enough!

As soon as produce is picked it starts to deteriorate and that process needs to be slowed by hydrating (hydrocooling) and/or cooling the produce to an appropriate holding temperature.

Temperature greatly impacts the quality and shelf-life of fruits and vegetables. Further, cold temperatures limit the development of microbial contamination.

GHP guidelines require monitoring and recording cooler temperatures on a regular basis.



CoolBot

CoolBot enables you to use an off-the-shelf window air conditioner to cool a **well-insulated** room down to 33-40 degrees.

\$300

www.storeitcold.com

- Cheaper up-front cost compared to standard walk-in cooler.
- Not optimal for farms needing to cool down significant volumes of produce
- Not ideal in terms of humidity
- Excellent option for the small grower or as a secondary, 40-55 degree cooler



Grower Tip: CoolBot Case Study

A small-scale grower in Wisconsin converted an old milk room on her farm to a walk-in “coolbot cooler.”

She reports spending a total of \$1,700 on this 11’ x 12’ x 6.5’ room including electrical updates, lighting, building materials, air conditioner and Coolbot unit.

She attached four inches of extruded foam panels to the concrete brick walls using long plastic cap nails and then covering it with vinyl coated milk board (MDF). A used 24,000BTU window air conditioner (\$200) powered through the Coolbot achieves temperatures around 36 degrees.



To get colder than 36°, she would have to have a better insulated floor but chose to stick with the pre-existing concrete floor with a built-in drain. She reports that it costs her \$700 to operate the cooler per year—much less than when she used a smaller, conventional walk-in cooler.



Wash Line (Brush Washer)

\$2,850 - \$4,360 Market Farm Implement

Friedens, Pa

www.marketfarm.com

814-443-1931





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Brush Washer Pricing

	16 inch	24 inch	32 inch	40 inch
Washer	\$1090	\$1295	\$1575	\$2050
In-feed Belt	\$435	\$470	\$520	\$610
Absorber	\$645	\$725	\$830	\$1025
Round Table	\$675	\$675	\$675	\$675
Full line	\$2845	\$3165	\$3600	\$4360



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Washing and Packing Equipment

Barrel washers are a fairly common piece of equipment on farms above 5 to 10 acres. They feature a rolling drum and spray nozzles. Used for root crops.

Cost: \$2,500 to \$3,000



The “Front End” of the Market Farm

- Plant Propagation
- Power/Traction/Horsepower
- Primary tillage tools
- Seeding



Walk-Behind Tractors

Walk-behind tractors (also called walking, 2-wheel rear tine tillers, or hand tractors) are used worldwide for small-scale farming.



Like any tool there is a range in price and quality available—from high-quality machines to cheaper units that are designed for more casual, home use. In general, the best quality machines are imported models (many from Europe) that are built to much higher standards of quality and durability expected of agricultural equipment.

Like a 4-wheel farm tractor, these rugged two-wheel machines are designed to run many attachments with a single power source and give thousands of hours of service.

EARTH TOOLS, Inc.

1525 Kays Branch Road
Owenton, KY 40359
(502) 484-3988 tel.



Walk-Behind Tractors

Walk-behind tractors can be very useful and effecting on a small market farm. Many farms start with a walk-behind tractor before “graduating” to a larger scale and their first (4-wheeled) tractor.

Walk-behind tractors do have limitations however:

- Although many attachments are available, some types of tools are simply not as effective as their tractor-mounted counterparts given limitations of weight, working depth, and horsepower/traction.
- In general, a tractor give you more options in terms of tillage equipment and allows you to be a better manager of the soil tilth and health.
- Walk-behind tractors do have an effective upper limit in terms of the acres they can be used on effectively...especially as a grower gets older and more limited in terms of strength, endurance, and durability.
- The best walk-behind tractors and their implements are not cheap.
- As a result, some growers end up regretting the money they invest in a walk-behind tractor system as they get older, expand, or run up against farm scale limitations.



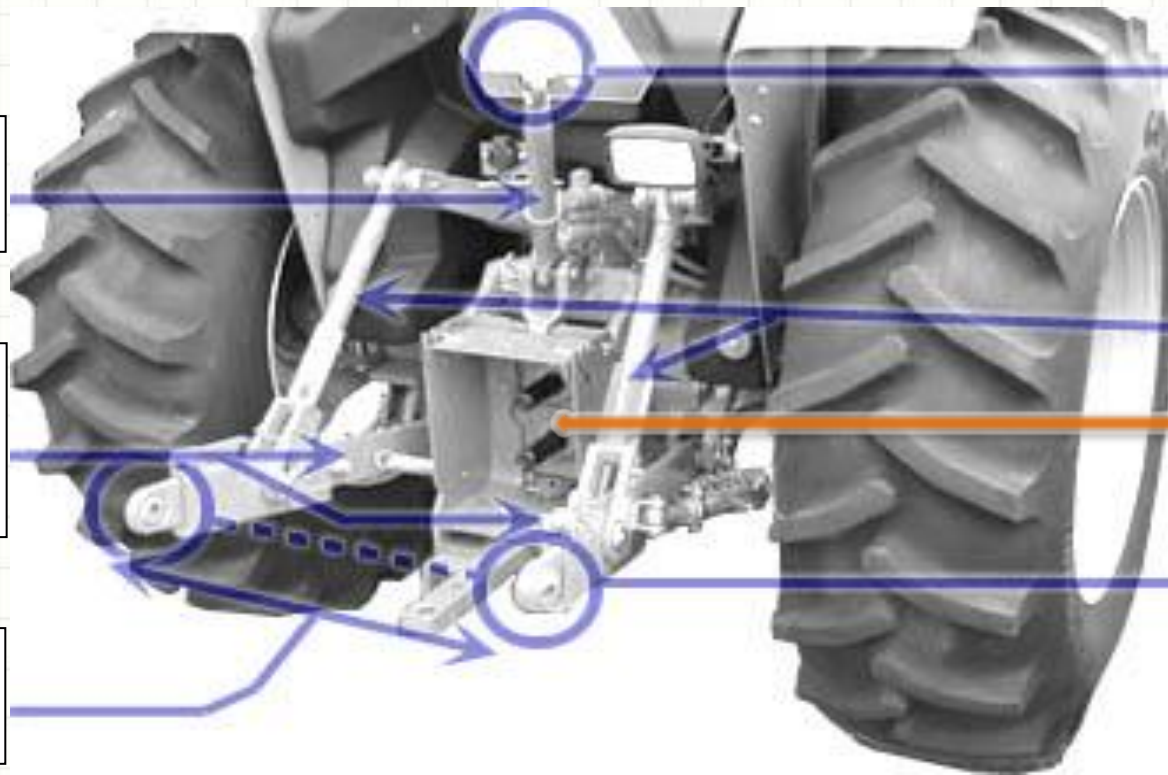
Four Wheel Tractors

Most growers, will at some point find themselves with a tractor. There is not time or space in this presentation to delve too far into this realm but here are a few basic guidelines and some general advice.

- New vs. used
 - Price
 - Consider your own mechanical knowledge/ability/time
 - Availability of parts and service
- Features to look for:
 - Wide front, high clearance
 - 30 to 60hp (or more)
 - 3-point hitch (consider category)
 - PTO and live hydraulics
 - Power steering
 - Safety features (ROPS)
 - Creeper gear or hydrostatic drive
- Implements:
 - Rotovator, field cultivator, mower, chisel plow
 - Front end loader, disk, plastic mulch layer, transplanter, sprayer
 - Harvesters, bed makers



Understanding Essential Tractor Features



Upper 3-Point
Link Arm

Lower 3-
Point Link
Arms

Lower Point
Span

Upper 3-Point
Hitch Point

3-Point Lift Arms

PTO Shaft

Lower 3-Point
Hitch Points



Commonly Used Primary Tillage Tools

- Moldboard plow



- Rototillers
Rotovators
(Spaders on next slide)



- Chisel plow



Spaders

Spaders come in two types: **rotary** and **articulated**. The “true” spading machine articulates and works like a hand spade shovel. The spade goes straight down into the ground and tips back on the up stroke, throwing the soil against the rear door to break it apart. A Rotary "Spader" works like a rototiller with a spade sweep moving in a circular motion. Rotary spaders can produce a finished seed bed (even in clay soil) and turn under all green matter in one pass with the optional rear power harrow BUT may cause soil compaction and smearing of the soil at the bottom of their depth of travel. Articulated spaders do not compact or smear the soil.



Celli Articulated Spader



Imants Rotary Spader

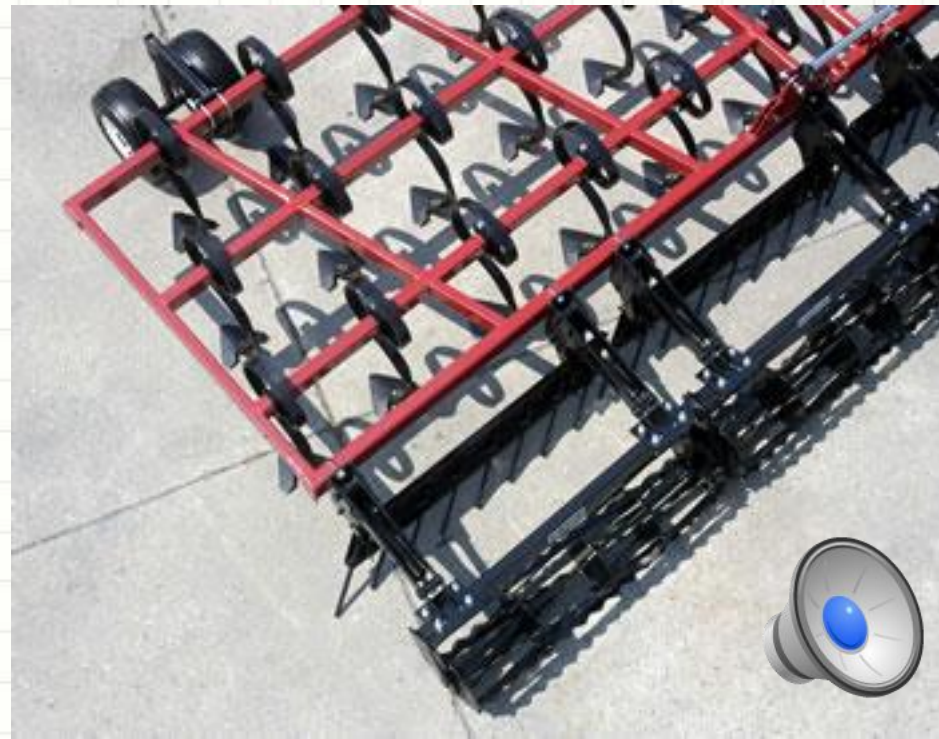
Field Cultivator

A field cultivator is a virtually essential tool on a market farm. Old ones can be adequate but newer models have additional features that make them more effective.

Shown here is the “Perfecta II” made by Unverferth in Ohio. It features three rows of S-tine sweeps, a leveling bar, and a rolling harrow at the rear.

Cost New: ~\$3,000-\$4,000

An old, used field cultivator can be found very cheaply at auctions.



Tillage Tool Basics

- Tillage tools that push soil horizontally (such as moldboard plows and disks) are useful for incorporating crop debris and cover crops but tend to create a plow pan
- Tillage tools that work the soil vertically are more gentle on soil structure but many do not incorporate residues as effectively
- Working the soil repeatedly with the same tool tends to create a plow pan and may also repeatedly create conditions that favor certain weeds or ideal conditions for certain pests
- It is best to have a number of implements in your tillage “toolbox”

Earthway

Almost all market farms
have one or at least
started with one.

Many have love – hate
Relationship with it.

\$90 - \$110

Local or mail order



Clean Seeders

Jang Automation (Korea)

Available through:

Mechanical Transplanter

mechanicaltransplanter.com

800-757-5268

Also available from: Johnny's

“Accurately singulates very small seeds and larger seeds with quick change seed rolls”

\$400+



\$980



\$975



Four Row Pinpoint Seeder

Excellent for salad green production

\$250 Johnny's

www.johnnyseeds.com

877-564-6697



Six Row Pinpoint Seeder

Excellent for salad green production

\$595 Johnny's

www.johnnyseeds.com

877-564-6697



Hatfield Transplanter

\$115

Johnny's

www.johnnyseeds.com

877-564-6697

Requires 2 people for efficient operation. Different models accommodate different sized transplants from a narrow model for alliums to a large model ideal for tomatoes and peppers. Can also be used for planting seed potatoes or for seeding things like corn squash and pumpkins. Can operate in bare soil or through plastic mulch.



Transplanters

Water Wheel

\$1900 base price

Market Farm Implement

Friedens, Pa

www.marketfarm.com

814-443-1931

A popular, “not too expensive” transplanter suitable to a variety of farms. Works best with plastic mulch but also works on bare soil (the drier and lighter the better). Tractor must have creeper gear. Can be set up for 1, 2 or 3 rows within a bed. It is somewhat cumbersome to change and adjust planting wheels.



Rolling dibble



Other Row-marking Devices



FIG. 31. POPULAR MARKER

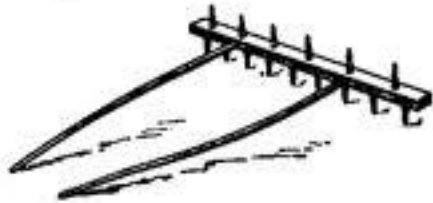


FIG. 32. HOMEMADE MARKER

~\$80 from Johnny's



The “Middle” of the Market Farm

- Irrigation
- Weed Management
- Insect and Disease Management
- Fertility and Cover Crop Management

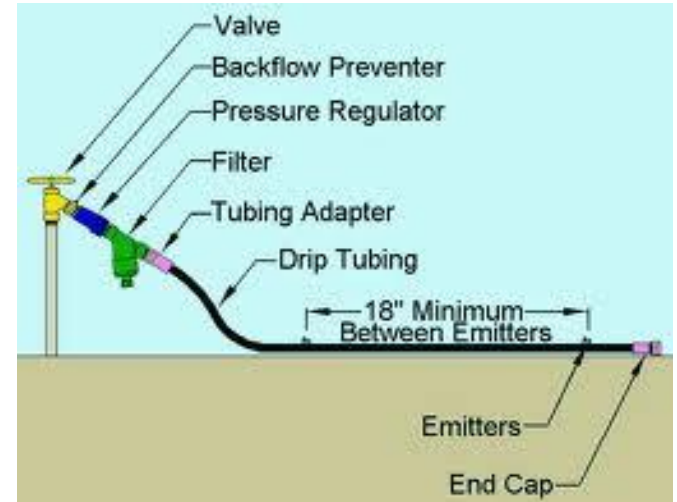


Drip Irrigation System

Basic Components

- Water source (well, pond)
- Back flow preventer
- Pressure regulator
- Filter
- Lay flat (or other line) to get water from well to field
- Header lines (lines along the edge of your field)
- Drip tape
- Various valves, couplers and adapters

Expect to spend between \$500 and \$1000 to get set up to irrigate an acre of vegetables



Professional Hand Hoes

Stirrup, scuffle, oscill



Lucko



Hand Hoe



Dutch Diamond



Diamond Hone



Gooseneck
Half-moon Hoe

Collinear



Wire Weeder

Wheel Hoes

Valley Oak \$300

valleyoaktool.com

415-868-9522



Glaser \$350

Available from Johnny's, Peaceful Valley and elsewhere

Wheel Hoes

Planet Whizbang wheel hoe

Free plans

Kits (metal parts only) \$150-\$175

<http://planetwhizbang.blogspot.com/>



Tractor Mounted Cultivators

At a smaller scale, the most versatile and cost effective tractor mounted cultivation system is likely a **toolbar** with a range of knives, sweeps, and shovels.

Other options include:

Tine weeders

Basket weeders

Finger weeders or Bezzerides Spyders

Torsion weeders

Regi weeder

Brush weeder



Excellent overview of tractor mounted tools:

<http://www.uvm.edu/vtvegandberry/factsheets/cultivators.html>

Tool Bar with Sweeps and Knives

Knives and sweeps are available in numerous sizes and shapes and can be mounted in countless configurations on a tool bar, such as the one below on a Farmall Cub tractor.



Sweep



Knives



S-Tine Cultivators

Consists of two or more toolbars with a series of tines that can be configured to cultivate between crop rows. A variety of points or “shovels” are available depending on how much soil you want to move and the crop to be cultivated. Not for close or precise cultivation



Tine (Flex Tine) Weeders

- Blind cultivation
- Adjustable tines
- Best on tiny (thread stage) weeds
- Stale seed bed prep

Brands:

Lely

Williams Tool System

(Market Farm Implement, PA)

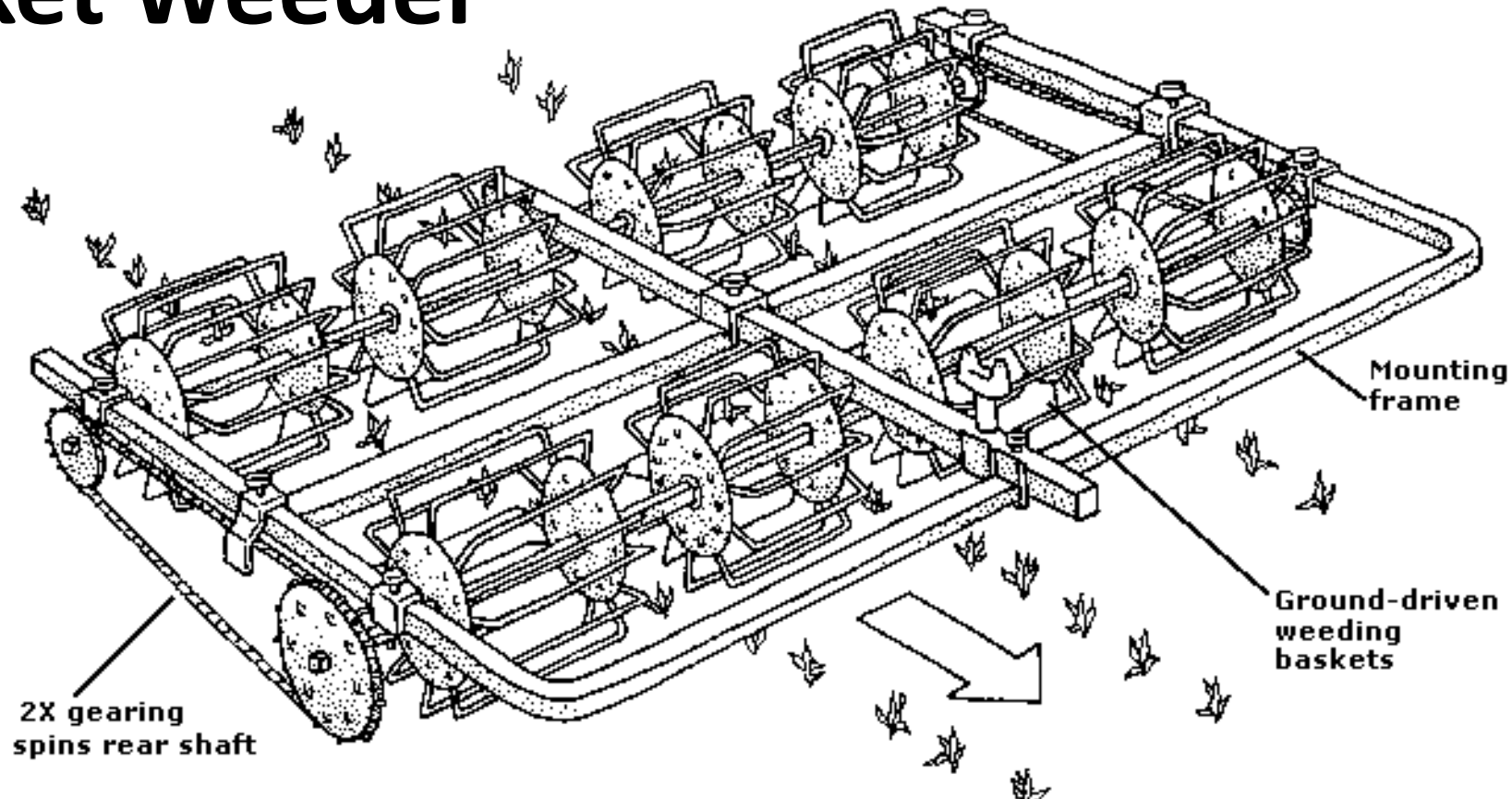
Einböck

Price (new):

\$1,800 to \$2,400



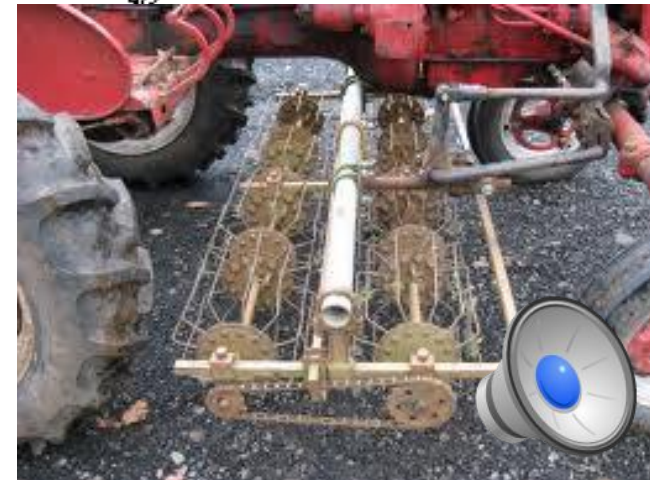
Basket Weeder



- Requires precisely spaced, parallel rows
- Usually belly-mounted
- Tiny and small weeds
- Stale seed bed prep

Brands: Budding Weeder Co. (Michigan)

Price (new): \$2500 to \$3600



Basket Weeder close-up: carrots



- Requires precisely spaced, parallel rows
- Tiny and small weeds
- Stale seed bed prep

Brands: Lely Williams Tool System Einböch

Price (new): \$1,800 to \$2,400



Finger Weeders

- In-row weeding capability on crops with strong stems
- Usually belly-mounted
- Removes 1" and smaller weeds
- Not good in rocky or crusted soil

Brands: Buddingh (MI), Kress (Germany), Baertschi Fobro (Switzerland)

Price (new): \$?



Torsion weeders

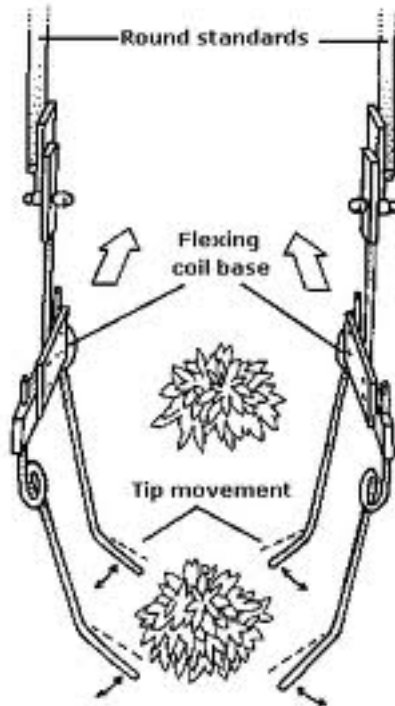
Cost: ?

Sources:

Bezzarides Inc.

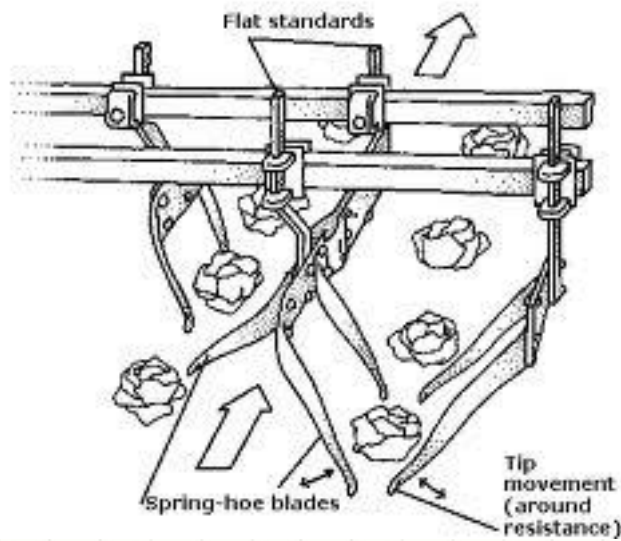
Frato (Dutch)

ItalianFarmMachinery.com



Torsion weeders consist of flexible tines tilted towards each other that undercut weeds close to the crop row with a vibrating, dragging movement. Because of its simple design, torsion weeders are relatively inexpensive. They can uproot small as well as decent-sized weeds but are best used only when the crop is well established.

Spring Hoes and Spyders



Cost: ~\$400 per row

Source:
Bezzerrides Inc.

Spring hoes are flat blades about 16 inches long. They are more aggressive than torsion weeders, traveling perpendicular to the surface and stirring soil just below ground alongside the root zone.

The 12 inch **Spyder** wheel has staggered curved teeth and is ground-driven. Pairs of spyders can be angled to pull soil away from the row or throw it back. Aggressive, rapid cultivation of straight rows is possible, even on stony soils.

These tools are often used in tandem or with torsion weeders.

Tillage and Cultivation in Clay Soils

Timing, as related to soil moisture, is far more important than the implement or tool. Clay soils should not be worked when they are too wet or too dry.

Persistent soil moisture, particularly in the spring and early summer when a great deal of cultivation is typically needed, can severely limit ones ability to cultivate at all when it is most timely from a weed growth stage perspective.

Weed cultivating tools that operate a shallow depth—where clay soils may be less moist and clodd—are best. These would include **torsion and finger weeders**. Another option would be a brush hoe...although these are heavy and expensive. Lightweight weeders, like the basket weeder, are unlikely to be effective.

Moisture levels are even more critical when performing tillage. For tillage, a **chisel plow and field cultivator** would be recommended. Rotovating and spading should be kept to a minimum.

To improve the tilth of clay soils, add as much **organic matter**, particularly compost, as you can. Do not add sand. It will take many years to improve h
clay soils



Plastic Mulch

Positives

- Prevents weed germination and growth
- Eliminates mechanical cultivation in the bed
- Conserves moisture (use of drip tape essential)
- Helps keep produce clean and can help reduce disease



Negatives

- Environmental concerns (manufacturing and disposal)
- Special challenges of controlling weeds in plant holes and along edges of plastic
- Need special equipment to lay out.



Round Bale Mulching

- Low tech weed control
- Helps build organic matter
- Conserves moisture
- Beautifies farm
- Prevents erosion
- Keeps produce clean

A 4 x 4 round bale weighs 500 to 700 pounds.

Rolled out, it will cover about 200 feet.

Avoid moldy hay or hay with thistles





Cover Crop Management

- Pre-plant field prep: Field cultivator
- Seeding options: drill or broadcast and lightly incorporate (cultipacker)
- Clipping and mowing: flail mower
- Incorporation options: rotovator or spader, disk, field cultivator, moldboard plow



Pesticide sprayers

At the smallest scale, pump-up canister sprayers, hand-pump backpack sprayers, and gas-powered backpack mist blowers are low-cost options.



15- to 30-gallon small tank sprayers powered by a 12-volt battery can be mounted on 4-wheelers or utility vehicles. Small pull-behind or 3-point hitch-mounted boom sprayers may be appropriate for larger acreages of low-growing vegetable crops.



For growers with a few acres of sweet corn, a high-boom sprayer that can pass through rows even when corn is 4 to 6 feet tall is usually a necessary investment. For orchards and vineyards, an airblast sprayer – either a pull-behind or 3-point hitch-mounted model – becomes a necessity as plants become large enough that spray penetration into the plant canopy requires air as an additional carrier. It's difficult and time-consuming to treat lots of trees effectively with a hand-sprayer, and applicator exposure is also a concern. ,



Other Useful Stuff

- Computer programs: Excel, Quickbooks, AgSquared
- Head lamp
- High lift jack
- Quality boots and wet gear!
- Ear protection
- Cement
- Professionals:
 - Accountant
 - Tax preparer
 - Consultants



Getting Started: What will it cost?

- \$10,000 per acre rule of thumb for capitalization
- Facility needs for 2 acre market farm:
 - Greenhouse: 400-600 square feet
 - Pack House: 150-300 square feet
 - Cooler: 150-250 cubic feet
- Priority Equipment needs:
 - Walk-in cooler
 - 30-60 hp tractor (and a walk-behind tiller)
 - Variety of implements (rotovator, mower, field cultivator, chisel plow, etc.)
 - Irrigation equipment
 - Hand tools (seeding and weed cultivation)
 - Harvest totes / Harvest cart / Scale / Wash tank
 - Delivery vehicle / Market tent / Computer



Build your own equipment!

Chris McGuire's laydown work cart



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Concluding Thoughts



- Think carefully about the best scale for your operation
- Set goals and create a capitalization budget
- Be cautious but not timid
- Learn from others; visit as many farms as you can
- Start small, be realistic, and enjoy the work!
- Always consider how each investment is meant to contribute to your business and its success.
- Always remember tools are no better than the person using them.
- No one is more important to your personal safety than you.
- If you don't believe work is your friend, it won't be.



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