

SIZING UP DIVERSE VEGETABLE FARMS: A NARRATIVE COMPANION TO THE SCALE OF PRODUCTION MATRIX

BEGINNING FARMER AND RANCHER
DEVELOPMENT PROGRAM GUIDE SERIES

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Author

Tom Cary
Program Manager, Farmer Field School
Student Organic Farm, Michigan State University

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About This Publication Series

This document is one of six resources in the Toolbox for Vegetable Farm Business Viability. The toolbox helps smaller scale vegetable farmers begin and progress along the path to business viability by assisting with planning, expenditures, and marketing. Toolbox resources are grouped into three categories:

- 1) Strategies for how to reach \$100,000 in sales: *Pathways to \$100K in Farm Sales* and *Pathways to \$100K Calculator*
- 2) Guidance on selecting a market that fits your farm: *Market Channel Selection Tool*
- 3) Suggestions for equipment and infrastructure investments for different scales (sizes) of farms: *Scale of Production Matrix* (information in table form and as a changeable Excel document), *Scale of Production Narrative* (a companion to the matrix with more details about different scales), *Scale of Production Optimization Tool* (generates suggestions based on your acreage, sales, etc.)

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➤ INTRODUCTION

This publication was created to be a helpful resource for beginning farmers when making decisions about infrastructure and equipment. We call it a “tool” in hopes that it will be, like other tools, something that helps you do your job as a farmer.

Purpose of the Scale of Production Tool

- Help farmers identify the possible infrastructure and key farm investments and costs they may be likely to expect at various scales of production
- Help farmers identify and prioritize key investments, based on investments that offer the best return. It could also help farmers who are thinking about increasing their scale or, to some extent, creating a leaner operation. The information is only presented here as increasing farm size but could also be useful for becoming leaner (e.g., more productive or efficient at the same scale).
- Expose farmers to some relative cost comparisons for better decision making

Decisions and Assumptions Made in Developing the Tool

- It is primarily designed for extensive (field-based, larger acreage), tractor-based, diverse, organic/sustainable, vegetable producers at the smaller scale in Michigan. This tool does not try to address the Biointensive, J.M. Fortier,

or highly hoophouse-focused or other highly intensive production approaches. It is hoophouse neutral; the tool does not assume that you should or shouldn't invest in season extension.

- The farm is business-oriented, income-generating, and on a path to reaching financial sustainability for the farmers (although using the *Scale of Production Matrix* will not guarantee financial stability), thereby assuming a trajectory of trying to reach at least \$125,000–\$150,000 in sales or \$30,000–\$50,000 in farmer income.
- Farm is on “average” (loamy) soil (neither pure clay or sand, etc.), avoiding some unique challenges of “pure” soils.
- Some choices are rated as “Y” (yes) that are perhaps not a great financial return on investment but have a good return on investment in quality of life and ease of work for the farmer and fellow workers.
- There is no infrastructure (buildings, well, greenhouse) or equipment on the farm at the start of the farm operation.
- Farmers tend to move from smaller to larger scale and/or from less to more mechanization over time and can often build upon the investments they have already made.

Limitations of the Tool

- This tool can only make generalizations as to if, when, or what investment in a tractor, equipment or infrastructure, or land is right for any given farm system, given the incredible variability of farm operations in goals, experience, and current conditions of any one farm.
- It cannot determine the right way for you to farm or the best or most ideal system for you.
- It cannot determine what is a good financial return on investment for all cases, what is just plain necessary, cost aside, or what is just worth it because life is better. Every farm's situation, at any given time, is different.
- It does not assume what water source is available to farmers. It assumes only that potable water for washing vegetables is an absolute necessity.
- It cannot predict how a farm is going to market its product, whether a farm is going to have to move most of its product off-farm for sale or sell it all on-farm, whether multiple large vehicles are needed, and so on.
- It cannot tell whether there is already infrastructure on the farm or if infrastructure must be built.

Layout of This Tool

The tool is organized based on farm sizes or scales, in acres, broken into five ranges:

- Less than 1 acre
- 1-2 acres
- 3-5 acres
- 6-10 acres
- 10-20 acres

These ranges were chosen in an attempt to highlight points of transition in production style that may occur as a farm scales up in size.

Companion Pieces

Further, the tool has three different but related parts. The first is the *Scale of Production Matrix*, a set of tables that break the equipment and infrastructure investments into eight categories and show the likely investment needs going across the five farm size ranges. The second is an online, customizable Excel version of the *Scale of Production Matrix*, which can be found at msuorganicfarm.org/resources. The third is this document, a narrative that includes some detail about expectations of work at each scale, a profile of a farm at that scale and some detail of equipment and infrastructure a farm might have at that scale, and a summary cost table of these likely equipment and infrastructure investments.

➤ FARMING ON LESS THAN 1 ACRE

This is a scale where many beginning farmers start, especially as they are moving from gardening and may have little farming experience. It is also a size that may be much more available and accessible, and it may fit well as you transition from other full-time employment into farming. It is a good size to start learning farming skills without a huge investment of time, equipment, and infrastructure while starting to be able to build a customer base and planning for greater production. Farmers with more farming experience, more time, and more access to capital may start a little larger.

Space

Less than 45,000 sq. ft. ($\frac{2}{3}$ soccer field); up to 75 beds 3' x 100', with 1 bed every 6 ft. of width

Skill Level

Beginning (0-2 years vegetable production experience). Learning and developing crop production and scheduling, field management, and harvest skills. *Tip:* Work on a farm that is operating the way you want to operate, and work there part-time while you start your own farm or full-time before starting.

Time

One person can manage this by working 30-40 hours per week for nine months of the year (depending on skill level, mechanization, and level of production). Hire part-time help during the August-September peak season.

Production Value/Sales

You could expect from \$1,000 (about \$5,000/acre) on the lower end up to \$15,000-\$25,000 (\$20,000-\$30,000/acre) in sales on the higher end, and more likely \$5,000-\$15,000, depending on size, crop type, intensity, market opportunity, and experience. It is very unlikely that you would achieve high-end sales in your first years as you learn the soil and landscape, develop production systems, and build name recognition, but decent sales are possible (see Example 1).

Farmer Income Potential

EXAMPLE 1: If you have $\frac{1}{4}$ acre with 16 beds (6ft. from bed center to bed center) with 3 rows of lettuce per bed at 1 ft. in-row spacing, you have 4,800 heads of lettuce. If we assume you can plant and harvest 4 plantings per season, that is 19,200 heads of lettuce. If you assume that you lose 20% of those heads for various reasons, that brings you to 15,360 heads. You can sell these wholesale for \$1.33 per head (Rodale Organic Price Report, 2016). That is about \$20,500 just from that $\frac{1}{4}$ acre.

\$2,000-\$12,000 (profit of 10%-40% of sales is typical¹). Often, profit margin is lower when starting due to crop losses, learning curve, and reinvestment and increases due to improved efficiency and experience. By *profit*, we mean what is left after all expenses except farmer income are subtracted from sales. In the start-up phase of the business, it is advisable to reinvest much of the profit (if any) back into the farm.

Infrastructure & Equipment Costs

About \$8,500 (low). The cost estimate and equipment outlined here offer a pretty bare-bones but feasible operation that does not include utilities, hired labor (spring tillage or harvesting help), or a delivery vehicle. This is a make-do farm operation. Spending another \$5,000-\$7,000 on some refrigeration and a vehicle would help a lot. Range: **\$8,000-\$25,000** depending on equipment choices and other investments, tractor purchase being the largest factor.

Cash Flow

The first half of the year, up to or around June, will require paying out of pocket with little income unless you get investment or "farm share" purchases, as in Community Supported Agriculture (CSA).

Land Ownership/Rental

It is advisable at this beginning stage to rent or lease land if possible. Purchasing land is often an unreasonable expense and risk at this stage.

¹ 31%-40% of sales in *Grower to Grower: Creating a Livelihood on a Fresh Market Vegetable Farm* by J. Hendrickson, CAIS, 2005; Groundswell Farm averaged about 15%-18% of sales in 2014-2016.

CASE STUDY 1

This farmer had one year of farming experience working at an area vegetable farm with CSA and farmers markets before leasing about an acre of land from a livestock farmer looking to diversify their product mix by partnering with a vegetable farmer. This vegetable farmer had no savings to capitalize the farm and was entirely reliant on income from CSA payments and borrowing from friends and family to get things started.

The farm owner tilled the land, helped with adding some soil amendments, and provided access to a small building on-site for equipment storage and access to a water line.

The vegetable farmer was responsible for all other aspects of production. A large rototiller and hand tools were purchased for the preparation and maintenance of beds, a push seeder for direct seeding, and hoses, connectors, and dripline for virtually all irrigation. A van was purchased for distributing the produce.

A pop-up tent and tarp were used for a wash station. In total, \$6,204 was spent on infrastructure, materials, and other production and sales expenses. Vegetable transplants were raised in a nearby farmer's greenhouse. A CSA share valued at \$450 was traded for land rent.

Vegetables were sold mainly through a 24-member CSA (\$450/share), at a stall at the local farmers market, and to some area restaurants and specialty retailers. CSA members and other volunteers helped with weeding, sales, and other aspects of production from time to time, but most of the work with many long days was done by the farmer.

That year, the farm had \$11,252 in sales and the farmer was paid \$4,800, with a net profit for the farm of \$248. This was the farmer's sole source of income. The farm did not continue into the second season due largely to financial pressure.

Investments to Farm on Less Than 1 Acre

Seeds & Transplants

No matter what scale, you want good quality seeds and a reliable seed starting or potting mix. You are going to need trays or a soil block maker to raise your transplants, a good technique or tool for dispensing the seeds into cells, and a good hose and a gentle spray nozzle with good control for watering. You may want to consider a heat mat and controller for getting the best germination of your tomatoes and other warm-weather crops. **Cost: \$1,000**

Tillage

At this scale, a broadfork, rototiller, or walking tractor are your tillage (soil/bed preparation) options if you are not buying a tractor. A used walking tractor (about \$850) is the best non-tractor option, and a new rototiller (about \$500) the next best option. A broadfork is a nice hand tool for breaking up soil in small areas. *Tip:* Always consider renting equipment if possible before purchasing. Contract with a local farmer to do your deep tillage in the spring if you don't have a tractor and tillage equipment. **Cost: \$850** (walking tractor)

Cultivation: Between-Row

A good tool for getting the areas between your rows of seeded or transplanted veggies and your walkways is a wheel hoe. Set up like a wheelbarrow, it allows you to quickly and efficiently wheel the cutting head of a hoe in between rows of plants. **Cost: \$225**

Cultivation: In-Row

The simplest weeding tool for getting in between the plants in a row is a good, sharp hand hoe, about \$50. It is worth having at least two so that more than one person can manage those pesky weeds. **Cost: \$100**

Seeding Implements

Directly applying seed into rows at the right depth and spacing is vastly improved over hand application with a push seeder. This is an indispensable tool. **Cost: \$140**

Harvesting Tools

You need the right tools (field knives, shears, digging forks) to get crops out of the field quickly, safely, and cleanly, and you need clean, sanitizable containers to harvest into and/or store produce in. **Cost: \$250**

Hand Tools (for Construction & Repair)

This may be forgotten in your budget, but having a good set of tools for building with wood or metal and assembling equipment or repairing machinery and buildings is indispensable for the running of the farm. **Cost: \$500**

Water Source

Vegetable washing requires a clean, drinkable source of water, but you may also need a clean water source for irrigation. At this farm size, try to (1) run a hose to a neighbor, connect to a city water hydrant, or see if the land owner can help (if renting); (2) if electricity or a generator is available, explore whether a hand-pounded well is an option (cost as little as \$500); or (3) the next best low-cost option is to move the vegetables off-site and wash them there or to move water to the site in tanks or totes, whichever is most efficient. *Only if you know for sure that you are going to be at this site for the long term (and have written and signed assurances from the land owner) should you explore the costly options of installing a well or permanent connection to a municipal water line.* **Cost: \$300** (paying to use someone's water source for a season) to **\$5,000-\$10,000** (depending on well depth and size) for a well, pump, and equipment or municipal hookup.

Irrigation System

In addition to water for cleaning and washing vegetables, you are going to want water for irrigating your field. This could be the water source (above) or an on-farm pond (with regular testing). In addition, you are going to need to have equipment for getting the water to where you want it and for applying it in the amounts you need. This includes drip tape, micro wobblers, or overhead sprinklers. You may also want to consider a timer and controller to turn water zones off and on in your absence. **Cost: \$225**

Produce Washing & Packing

At a minimum, you are going to need a few sinks, some sort of covering for shade and protection from the wind and rain, and a place to pack, drain, and stage your produce. You can do it for less, especially if you don't have infrastructure. **Cost: \$1,260**

Produce Sales & Delivery

You are going to need some equipment and infrastructure for presenting, selling and/or delivering your produce. This includes folding plastic tables, at least one 10' x 10' pop-up canopy (to protect produce from the weather), certified scales for measuring out quantities, and signage to promote your farm and produce prices. If you deliver produce off-farm, depending on your farm's size, you may be able to use your personal vehicle initially. **Cost: \$2,030**

Information, Financial, & Media Management

Tools for organizing and marketing your farm business are worth every penny of investment. At a minimum, this includes a computer and printer, software, phone, and a website. **Cost: \$1,700**

Land Tenure

You are going to need to have some control of the land you are growing on, either by renting or purchasing it and having a down payment and a mortgage. *(A lot of planning and research should go into selecting a piece of land to farm and even more before making a purchase.)* At less than 1 acre, renting is a very good place to start. **Cost: \$250** (about \$150 per acre is average Michigan rent for larger acreages)

Table 1. Farming on Less Than 1 Acre

	Need it?	Cost*
SEEDS & SEEDLINGS		
TOTAL		\$1,000
MACHINERY & EQUIPMENT		
Tillage machines	Y	\$850
Full-size tractors	N	-
Cultivating tractors	N	-
Tillage implements	N	-
Bed preparation	N	-
Seeding implements	Y	\$140
Planting/transplanting	N	-
Cultivation: Between-row	Y	\$225
Cultivation: In-row	Y	\$100
Pest management	N	-
Harvesting implements	Y	\$250
Construction, repair, & maintenance tools	Y	\$500
TOTAL		\$2,065
INFRASTRUCTURE		
Hoophouses	N	-
Wash/pack station	Y	\$1,260
Walk-in cooler	N	-
Water source	Y	Varies
Irrigation system	-	\$225
TOTAL		\$1,485
PRODUCE SALES & DELIVERY		
TOTAL		\$2,030
INFORMATION, FINANCIAL, & MEDIA MANAGEMENT		
TOTAL		\$1,700
RENT/MORTGAGE		
TOTAL		\$250
GRAND TOTAL		\$8,530*

* Does not include cost of drinkable water source.

➤ FARMING ON 1-2 ACRES

Growing at this scale often benefits from moving into a tractor-based system, especially if you are planning to grow into more acreage in the future. While some farms in the United States have been successful using intensive non-tractor methods at scales up to 5 acres, they are exceptional. At this scale, you may still be able to apply many of the methods and equipment you needed for less than 1 acre (see previous section); however, you will find that it is going to take much more time to do everything. While a walking tractor and implements are still very helpful at this scale, many tasks can be made much easier and done more efficiently with a tractor and tractor-mounted implements and/or additional equipment, as outlined in this section and in the *Scale of Production Matrix* tables.

Space

45,000–90,000 sq. ft. (about $\frac{2}{3}$ to $1\frac{1}{2}$ soccer fields); 50–100 beds 100 ft. long at 6 ft. spacing

Skill Level

Beginning (1-3 years experience). Experience with crop production planning and scheduling, field management, and harvesting is advised at this scale. If CSA is a component of sales, farmers are strongly advised to have experience with reliable CSA production. *Tip:* Work on a farm that is operating the way you want to operate, and work there part-time while you start your own farm or full-time before starting. It is not advised to start at this scale without any vegetable production experience.

Time

Two people can typically manage this scale, investing 30–50 hours per week on average. Hire part-time help during the August–September peak season.

Production Value/Sales

You could expect from \$5,000 (about \$5,000/acre) on the lower end up to \$20,000–\$60,000 (\$20,000–\$30,000/acre) in sales on the higher end, and more likely \$15,000–\$25,000, depending on acreage, crop type, intensity, market opportunity, and experience. As stated previously, it is very unlikely that you would achieve high-end sales in your first years as you learn the soil and landscape, develop production systems, and build markets.

Farmer Income Potential

\$4,000–\$24,000 (profit of 10%–40% of sales is typical; see footnote 1, p. 6). By *profit*, we mean what is left after all expenses except farmer income are subtracted from sales. In the start-up phase of the business, it is advisable to reinvest much of the profit (if any) back into the farm. At this scale, we are starting to approach enough income to support a full-time farmer.

Infrastructure & Equipment Costs

About \$37,500 if you are starting at this level, or **about \$29,200** if applying investments from farming on less than 1 acre to this scale. Range: **\$30,000–\$45,000** depending on equipment choices and other investments, tractor purchase being the largest factor.

Cash Flow

The first half of the year, up to or around June, will require paying out of pocket with little income unless you get investment or “farm share” purchases, as in CSA. Developing other markets (restaurants, key farmers market customers) that may be willing to prepay a portion of sales through a spend-down account prior to June is a good idea, if you are very confident to you can meet the commitment.

Land Ownership/Rental

It is advisable at this beginning stage to rent or lease land if possible (though that is not always an option). Purchasing land is a significant expense and risk in your first couple of years as you develop your farm business. However, you should be thinking about either a long-term lease or an option to buy if the land is good, you have room to grow, and there are other outstanding benefits to the site. If not, you should be starting to look at other suitable locations. Some excellent resources for understanding your options, finding resources and possible land opportunities can be found at miffs.org/services/beginning_farmers/land_access_program.

CASE STUDY 2

In 2006 two friends, both women, decided to start a farm together. They came with six years of farming experience between the two of them and had worked together on a nearby farm the previous year. This farm had about 200 CSA members, a large farmers market stall, and around \$200,000 in sales. They had searched for land and found a suitable parcel of 7 acres that they rented for the first two years for very little.

That first year, they hired a local farmer to till the soil in the spring, and they used a rototiller to prepare and manage the beds that season. They had 1.5 acres of vegetables and about 3.5 acres in cover crops. They purchased and built a 16' x 48' greenhouse (and had a heater installed), and they built an 8' x 8' walk-in cooler (purchasing the cooler unit). Because there were no buildings on the site,

they purchased a 10' x 20' heavy-duty "garage in a box" type tent for their vegetable wash station.

That year, the farmers also purchased a full-size 2-wheel-drive pickup truck for CSA and farmers market. They also had a 125-foot 4" well installed for irrigation and vegetable washing. In addition, electricity was run to the farm, and an electrician installed a mast, meter, and breaker box.

They put \$20,000 of their own money into the farm account to get things started. They had sales of \$17,000 between CSA and farmers market and had \$12,000 in expenses, and each took \$1,000 in income from the farm that year.

Investments to Farm on 1-2 Acres

Seeds & Seedlings

You'll need to spend more on potting mix, trays, and seeds. Adding a heat mat and controller will greatly increase the germination of your warm-season transplants, such as tomatoes. **Cost: \$1,500**

Machinery

At this scale, larger machinery is likely going to become a very important part of your farm operation. Purchasing a full-size tractor at this point is advisable, as well as a push rototiller or a used walking tractor (handy for partial bed or hoop house work). *Note:* The argument against a *new* walking tractor (\$3,000) is that it is cost/time efficient only up to a couple of acres, and for the price, a full-size tractor is probably a much better investment if you plan to grow. **Cost: about \$7,350** (\$6,500 tractor, \$850 used walking tractor with tiller)

Tillage/Bed Preparation

If you purchase a tractor, you are also going to want to also get a tractor-mounted rototiller for making a nice bed for seeding or transplanting into. It is advisable to buy new as tractor-mounted rototillers have critical components that you cannot inspect easily to know if a used one is damaged goods. If you are converting fallow ground, a two-bottom

plow might be a good addition for \$400 or so. Cover crop anything you don't think you will use this season. **Cost: \$1,500** (tractor-mounted rototiller)

Seeding/Transplanting

For the crops you don't transplant, you are going to need a direct seeder. A new low-cost push seeder is great for this size farm. You can also find them used. **Cost: about \$140** (new)

Cultivation

A few specialized vegetable hand hoes and a wheel hoe are extremely effective. *Note:* If you have purchased a tractor, keep your eye out for affordable cultivating attachments that could help you keep up with weeds. **Cost: \$425**

Pest & Disease Management

Managing pests and diseases on your farm is very important. Purchasing a backpack sprayer is a very good investment at this point. **Cost: \$125**

Harvesting Implements

Add enough harvest carts, harvest bins, and harvesting tools to keep things as efficient as possible. **Cost: \$750**

Tools

Having a complete set of power tools and hand tools for building, maintaining, and repairing your infrastructure and equipment is essential. It is also advisable to have some basic guidebooks on wiring, plumbing, and construction and service manuals for your machines and equipment.

Cost: \$1,000 (on average, new or used)

Water Source

If you don't have access to enough clean water, you are going to need to invest in a drilled well and pump (and possibly also electrical service, etc.). **Cost: \$5,000**

Irrigation

Additions include an expansion of your drip system and 2-inch layflat mainline to increase water access. **Cost: \$450**

Hoophouses

Transplant Production House: If you are unable to purchase transplants or unable to rent greenhouse space, you are going to need to build your own greenhouse. This is commonly done in a hoophouse with a heater and a double layer of plastic film or in a self-designed structure built on the south side of an existing building (less expensive). If you choose the hoophouse option, one 14'-18' wide would be advisable as it is easy to construct, very stable under snow and wind loads, and easily expanded. A 16' x 48' hoophouse is a good size for this scale, and adding length as you grow is easy. **Cost: \$5,215** (new, with heater, venting, plastic, and structure, including wood baseboards)

Wash/Pack Station

Having a couple of 10' x 20' canopies ("garage in a box" style), sinks, and harvest bins could help with shading and moving the harvest quickly through to your storage area or cooler. **Cost: \$2,470**

Walk-in Cooler

This is one of your most important investments in the farm. Luckily a recently developed device called the CoolBot has made good quality refrigeration for your vegetables affordable. The CoolBot is a device that electronically controls an air conditioner to make it cool down to 38°F or so, enough to refrigerate vegetables (\$300). You can build an 8' x 8' x 8' cooler with 2x4 construction and lots of foam board for about \$800 or less and may be able to pick up a used cooler for not much more. A new air conditioner in the 15,000-24,000 BTU range is about \$600. Locate your walk-in cooler in a building or in the shade if possible. **Cost: \$1,300** (on the low end)

Produce Sales & Delivery

Used Pickup Truck or Van: A reliable used utility/cargo van or 2-wheel-drive pickup truck (below 150,000 miles) costs \$5,000-\$7,000 and is a reliable first purchase. Vans have more storage volume than a truck with a cap, but trucks are more versatile on the farm. Also needed are a pop-up tent or two, a legal scale, folding tables, and signage. **Cost: \$7,810** (\$6,000 on average, used vehicle; \$1,810, marketing)

Information, Financial, & Media Management

In addition to having a computer, a smartphone, and a website, you may want to consider financial management software for the business. **Cost: \$1,700**

Land Tenure

Renting farmland at this point is still advisable, but look for a permanent site. **Cost: \$500** (rent)

Table 2. Farming on 1-2 Acres

	Need it?	Cost*
SEEDS & SEEDLINGS		
TOTAL		\$1,500
MACHINERY & EQUIPMENT		
Tillage machines	Y	\$850
Full-size tractors	Y	\$6,500
Cultivating tractors	N	-
Tillage implements	Very Helpful	-
Bed preparation	Y	\$1,500
Seeding implements	Y	\$140
Planting/transplanting	N	-
Cultivation: Between-row	Y	\$225
Cultivation: In-row	Y	\$200
Pest management	Y	\$125
Harvesting implements	Y	\$750
Construction, repair, & maintenance tools	Y	\$1,000
TOTAL		\$11,290
INFRASTRUCTURE		
Hoophouses	Y	\$5,215
Wash/pack station	Y	\$2,470
Walk-in cooler	Y	\$1,300
Water source	Y	\$5,000
Irrigation system	Y	\$450
TOTAL		\$14,435
PRODUCE SALES & DELIVERY		
TOTAL		\$7,810
INFORMATION, FINANCIAL, & MEDIA MANAGEMENT		
TOTAL		\$1,700
RENT/MORTGAGE		
TOTAL		\$500
GRAND TOTAL		\$37,235
<i>Cost of building on previous scale investments</i>		\$29,205

* Note: "Costs" represents the total investments in this category up to and including this scale, not just those from the Investments to Farm 1-2 Acres section. These costs are detailed in the Scale of Production Matrix.

➤ FARMING ON 3–5 ACRES

As you grow to this scale, you may find practices that worked at 1–2 acres no longer work as well. At this scale, you are often growing a larger quantity of each crop. Whereas running a wheel hoe on 1 acre was doable, it is not practical on 5 acres, so tractor-mounted tools should be considered, especially for cultivation. Some level of equipment and management specialization may make sense, too—whether you need a two-row cultivator or a production manager, these specializations are changes that help with increasing the efficiency of work on the farm. The farm is also going to need to plan for increased personnel as it grows. Finally, marketing is going to increase in focus now that the farm can produce much more produce than can be casually sold.

Space

About 100,000–225,000 sq. ft. (about 1 ½ to almost 3 soccer fields); 100–250 beds 100 ft. long at 6 ft. spacing

Skill Level

Moderate (2–5 years experience). This is a good scale to continue to learn and develop your crop production, management, and harvest skills. Developing reliable greenhouse transplant production and crop scheduling at this point should be a major focus. Some personnel management, good employee hiring practices, and regular weekly schedules, including a weekly farm walk, are other practices to implement. Also, marketing and financial management are much more important at this scale.

It is *strongly advised* that you have some experience working on a farm at this scale before you start, and better yet, start at a smaller scale (between 1–2 acres) and work up to this.

Time

Five or six people can typically manage this scale investing 30–40 hours per week on average, but with many more hours per week during peak production from late July through early September. This of course would also depend on the intensity, crop type, and equipment used. A walking tractor or

full-scale tractor with implements, even at this scale, will save considerable time over using a rototiller and doing your weed management by hand.

Production Value/Sales

You could expect from \$15,000 (about \$5,000/acre) on the lower end up to \$100,000–\$160,000 (\$20,000–\$30,000/acre) in sales on the higher end, and more likely \$30,000–\$75,000, depending on acreage, crop type, intensity, market opportunity, and experience.

Farmer Income Potential

\$5,000–\$60,000 (profit of 10%–40% of sales is typical; see footnote 1, p. 6). By *profit*, we mean what is left after all expenses except farmer income are subtracted from sales. At this scale, we are at a point where enough income is likely available to support a full-time farmer. It is a good rule of thumb that most of the profit (if any) during the first three years of production would be invested in the farm and little, if any, would be taken as profit by the farmer.

Infrastructure & Equipment Costs

About \$65,000 (\$40,000–\$70,000 range) if you are starting at this level, or **about \$28,000** if you are able to apply investments from farming 1–2 acres to this scale. These are detailed below and in the *Scale of Production Matrix*.

Cash Flow

With a likely increase in employees to run the farm, you may need a full staff as early as mid-May. July payroll may be tight. Try to get up-front partial payments from larger accounts, utilize “farm share” (CSA) sales, or consider a bridge loan if needed until late July/August, when sales of summer crops can result in increasing cash flow.

Land Ownership/Rental

At this scale, it may be time to consider a land purchase or at least a long-term lease to protect your operation, if the land is a good fit and you are needing to make some infrastructure investments that might stay with the land. (See resources given in the Land Ownership/Rental section on page 10.)

CASE STUDY 3

This couple moved to Michigan to start their farm. With almost nine years of farming experience under their belts, having worked at large and small vegetable farms, they started their own farm in 2015 on about 2 acres. The farm had a house, well, and outbuildings. That year they bought a tractor and a 3-point rototiller, a 2-bottom plow and a disk, and a pickup truck for produce delivery and market setup, and they built a small greenhouse for starting transplants. That year they had about \$45,000 in sales from one farmers market, 40 CSA members, and some sales to specialty stores. Besides the two full-time farmers, they had a lot of on-farm help from their parents and substantial family help in purchasing the land.

The following year, 2016, was a hard year—too wet and not enough time to get everything done. They added some part-time help, cultivated about 3 acres, and grew their CSA and improved at market. They grew their sales to \$60,000, but it was hard fought.

By 2017, they added two season extension hoophouses, two cultivating tractors, a basket weeder, and a tine weeder. They also upgraded their electrical system to make it safe, cultivated 4 acres, and became certified organic. With investments in mechanization, better weather, adding a fall CSA share option, increasing their presence at farmers markets, and reaching 70 summer CSA shares, their sales are on track to be over \$100,000 and the farmers feel much better about farming than in 2016.

Their goals looking forward are to continue to grow their CSA, explore adding a new farmers market, get leaner (do more land without adding a lot of labor), add storage space for winter storage crops, add delivery truck capacity, explore some better irrigation for the greenhouse and fields, and in the longer term, get more land so that they can keep more ground in cover crops for longer to improve their soil.

Investments to Farm on 3-5 Acres

Seeds & Seedlings

Expenses for seeds and soil mix are growing. You are probably going to want to add a second heat mat for your increased Solanaceae seedlings. You may want to also explore the idea of a germination chamber. **Cost: about \$4,000**

Machinery

At this scale you need a tractor and the implements that go with it, period. This is going to be a significant investment if you have not already made it. Consider both new and used tractors in the 50-70 horsepower range (a little lower if 4WD). Used tractors worth buying are often a quarter to half the cost of new, but you have to pay cash. If a cash purchase is not possible, a loan to purchase a new or nearly new tractor would allow you to get more tractor at an affordable rate. **Cost: \$8,500** (used, 50+ HP & bucket)

Tillage

You are going to want at a minimum a two-bottom (three- to four-bottom, if you can pull it) plow for deep tillage of fallow fields, a disk for breaking larger clods of soil and helping incorporate vegetable material and cover crops, and a subsoiler to help break up the subsoil often compacted by your tillage implements. **Cost: \$2,075**

Bed Preparation/Seeding/Transplanting

You want to buy a tractor-mounted rototiller new, as it has parts that are difficult to check on a used piece of equipment. **Cost: \$1,500.** You may also consider a bed shaper or a plastic mulch layer. For the crops you don't transplant, you are going to need a direct seeder. A new or used low-cost push seeder is a good fit for this size farm. **Cost: about \$140** (new)

Cultivation

Tractor-mounted cultivation is critical to managing weeds at this scale. Even if you use a lot of plastic mulch, you will need to cultivate direct-seeded crops. If you don't yet own a cultivating tractor, purchase (or have made) a three-point toolbar (or a walk-behind tractor toolbar) for mounting cultivating components (about \$1,000). As a first choice for getting a very delicate cultivation option for less than \$400, you could mount three sets of tines on your tool bar.² These can be used on a variety of plants at various stages and adapted for one, two, and three rows. In addition, a good used field cultivator with various sweeps or another component that can handle a bit larger weeds and adapted for full-bed or one, two, or three rows is very useful (about \$1,000). If you must choose between two or three rows, choose the three-row style cultivator. Enough hoes and a couple of wheel hoes add another \$850. **Cost: about \$3,210**

Pest & Disease Management

Managing pests and diseases on your farm is very important. Purchasing a backpack sprayer is a very good investment at this point. **Cost: \$125**

Harvesting Implements

The most important additions at this scale would be a Middlebuster (or "potato plow") for digging up potatoes, an undercutter bar or "lifter" to free up garlic, leeks, celeriac, and a few other root crops, and a hay wagon (for mass harvesting crops). These will allow you to use that tractor to make your work easier and more efficient. **Cost: \$3,450**

Tools

Having a complete set of power tools and hand tools for building, maintaining, and repairing infrastructure and equipment is essential. It is also advisable to have some basic guidebooks on wiring, plumbing, and construction and service manuals for your machines and equipment. **Cost: \$1,000** (on average, new or used)

Irrigation/Water Source

In addition to a well, you will want to increase your water infrastructure, extending mainlines, drip systems, and overhead sprinklers. A mini traveler may be a worthwhile investment (about \$1,800). **Cost: \$6,200**

Hoophouses

While something like a 16' x 48' initial greenhouse (transplant production house) space was sufficient at a smaller scale, as you grow toward 5 acres of production, you are going to be growing a lot more transplants and may need to expand or extend your greenhouse to 1,100 sq. ft. of space and equipment. If starting from scratch, this may run about \$7,200, but if you just extend the greenhouse you have, it might cost you \$500–\$1,000 if used and \$3,400 new. **Cost: \$7,157**

Wash/Pack Station

In addition to adding more space, more sinks, and more tools than you had at the previous scale, it would be good to purchase or make a barrel washer and convert a top-loading washing machine to a salad spinner to improve post-harvest efficiency. **Cost: about \$5,220**

Walk-in Cooler

If you harvest a quarter acre or more each of potatoes, onions, garlic, and winter squash, you are going to have a lot of product to store in cool/dry storage. You are also going to need increased cold storage. **Cost: \$2,800** (If you lack available buildings on your farm, a used insulated semi-trailer is an option. **Cost: \$1,600**; add \$800 for CoolBot & air conditioner.)

Produce Sales & Delivery

Two vehicles may be needed to deliver your produce to CSA, farmers markets, specialty stores, a food hub, or wherever it needs to go. You may also need the portable infrastructure for CSA or market setup. You may need to rent a box truck in peak season to carry the volume you need. **Cost: \$16,890**

Land Tenure

The lowest cost option as presented here is still renting land; however, as you get to this scale of business (and probably before you make these kinds of investments), you are going to want some security, and that usually means either a long-term lease agreement or land purchase. **Cost: \$1,000** (rent). (See resources given in the Land Ownership/Rental section on page 10.)

² See: http://www.marketfarm.com/cfms/lely_weeder.cfm According to Josh Volk (<http://www.joshvolk.com/Q%26A/lelyforacgs.html>), in 2008, tines were \$15 each and brackets \$15 each; 3 sets of 4 tines plus brackets for 3 row = \$360.

Table 3. Farming on 3–5 Acres

	Need it?	Cost*
SEEDS & SEEDLINGS		
TOTAL		\$4,000
MACHINERY & EQUIPMENT		
Tillage machines	N	-
Full-size tractors	Y	\$8,500
Cultivating tractors	N	-
Tillage implements	Y	\$2,075
Bed preparation	Y	\$1,500
Seeding implements	Y	\$140
Planting/transplanting	N	-
Cultivation: Between-row	Y	\$2,450
Cultivation: In-row	Y	\$760
Pest management	Y	\$125
Harvesting implements	Y	\$3,450
Construction, repair, & maintenance tools	Y	\$1,000
TOTAL		\$20,000
INFRASTRUCTURE		
Hoophouses	Y	\$7,157
Wash/pack station	Y	\$5,220
Walk-in cooler	Y	\$2,800
Water source	Y	\$5,000
Irrigation system	Y	\$1,200
TOTAL		\$21,377
PRODUCE SALES & DELIVERY		
TOTAL		\$16,890
INFORMATION, FINANCIAL, & MEDIA MANAGEMENT		
TOTAL		\$1,700
RENT/MORTGAGE		
TOTAL		\$1,000
GRAND TOTAL		\$64,967
<i>Cost of building on previous scale investments</i>		\$27,732

* Note: "Costs" represents the total investments in this category up to and including this scale, not just those from the Investments to Farm 3–5 Acres section. These costs are detailed in the Scale of Production Matrix.

➤ FARMING ON 6–10 ACRES

Farming at this scale is much like working at 3–5 acres with some increased space for transplant production, refrigeration, and mechanization, such as a cultivating tractor and a transplanter. It may also require scaling up your delivery vehicle to a box truck to be able to move the quantity of product you are growing now. Probably the most important changes that affect a farm at this scale are the increased need for efficient management (of information and people), knowledgeable managers, and having good systems in place (propagation/scheduling, production, post-harvest/food safety, finances) that people can be trained to learn and follow. At the 3–5 acre scale, you can develop these systems, but you are going to want to have them in place at this scale.

Space

250,000–450,000 sq. ft. (about 3 to 5 ½ soccer fields); 250–500 beds 100 ft. long or 100–200 beds 250 ft. long at 6 ft. spacing

Skill Level

Experienced (5+ years of experience). At this level, you need to have honed your management skills and have a management structure as well as production planning, marketing, and harvest systems in place. You should also have very good financial and record-keeping practices. In short, your farm can run as a business, and you have the capacity to guide it in the direction needed.

Time

Typically, 8–12 people can manage this scale investing 40 hours per week on average for a mostly direct market sales farm, or less with higher mechanization/standardization, or fewer people with longer hours. Managers will need to put in more like 45–50 hours per week and often more during peak production, from late July through early September. This of course depends on the intensity, crop type, and equipment used.

Production Value/Sales

You could expect from \$60,000 (about \$10,000/acre) on the very low end up to \$150,000–\$300,000 (\$25,000–\$30,000/acre) in sales on the higher end, and more likely \$120,000–\$200,000 on average, depending on acreage, crop type, markets, and experience. It is unlikely that you would achieve high-end sales in your first years on a piece of land or community as you learn the soil and landscape, develop production systems, and build name recognition.

Profit/Income

While profit can vary wildly, one could expect somewhere between 10%–40% profit (profit = sales – expenses), which could be in the range of \$12,000–\$80,000.

Infrastructure & Equipment Costs

About \$160,000 (range: \$140,000–\$180,000) if you are starting at this level, or **about \$95,000** if applying investments from farming 3–5 acres to this scale. These are detailed below and in the *Scale of Production Matrix*.

Cash Flow

In many less mechanized, direct-market operations, full staff is often needed as early as mid-May, well before sales can cover labor costs. You need to plan for having upwards of six weeks of payroll in cash reserves at this time. This can be carryover from the prior year, up-front payments from larger accounts, “farm share” (CSA) sales, or a bridge loan, if needed. By late July/August, sales of summer crops can result in increasing sales that can balance labor costs.

Land Ownership/Rental

At this scale, it is very important to own your land or have a long-term lease to protect the core of your operation (where most of your infrastructure is located) and have very clear legal protections of your investments in the lease. If land is limited, consider leasing adjacent or nearby land for more space-intensive, long-season crops such as winter squash, sweet corn, and potatoes. (See resources given in the Land Ownership/Rental section on page 10.)

CASE STUDY 4

In the early '90s, this Michigan couple started growing bigger and bigger organic gardens while working and pursuing their degrees. In 1996, when the garden got too big, they started going to the local farmers market. Once they started at the market, they started to grow bigger to fill their market stall. By 1998, they found themselves farming pretty much full-time, with two greenhouses, raising 1.5 or so acres of vegetables, still using a rototiller. Then they started a small CSA. Within a few years, they had 50 members and had a tractor and a 3-point rototiller.

Twenty years on, they have 80 acres where they farm and live. They cultivate about 6 acres and they have a pole barn for storage, work, and their self-made walk-in cooler, as well as five hoopouses, two pickup trucks, and a trailer for delivery. Currently they sell about \$90,000 in vegetables and flowers at two farmers markets, to a 40-member CSA, and through special orders (restaurants and grocery). They are growing more than they can sell. All the work is

performed by the two farmers, working 50 to 60 hours per week, plus three half-time seasonal employees.

Their most important investments were the pole barn (the original barn was too costly to restore and blew down), the tractor and 3-point rototiller, upgraded electrical service, underground waterlines with planned stand-up hydrants for each field (hoses were a nightmare), the hoopouses for season extension, and adding delivery capacity with the trailer and building a box with shelves on the back of the pickup truck.

Looking forward, they would like to become a more efficient (leaner) operation by being more disciplined about succession planting to spread out production better and attune it more closely to their demand, get a bigger delivery truck, grow the CSA to 70 members or more, hire more employees to take some pressure off themselves, and build up their best farmers market and drop the less profitable one.

Investments to Farm on 6–10 Acres

Seeds & Seedlings

You will have increased seed and soil mix costs, and you are going to want additional heat mats or germination chamber space for Solanaceae and other warmth-loving seedlings. **Cost: about \$8,000**

Machinery

Cultivating Tractor: With underbelly-mounted cultivators, cultivating tractors allow for very precise and efficient cultivation on single-row or multiple-row plantings. Some new cultivating tractor manufacturers exist, but most affordable are the used (sometimes more than 50-year-old) tractors. Prices range from \$1,000–\$1,500 for a Farmall on the low end to \$12,000–\$13,000 for a brand-new Tuff-bilt/Oggún. **Cost: about \$4,000**

Full-Size Tractors: In addition to your first, perhaps smaller tractor at around \$6,500, you are going to want a second tractor. One tractor equals one person at a time doing tractor work, so the tractor becomes a limiting factor to getting work done. Adding a

second tractor can double the pace of work at key times and minimizes trading out implements. Often, the second tractor is set up and ready to go for a seasonal task (bed preparation, cultivation, etc.). With a higher horsepower second tractor (with a bucket and fork attachments), you can do more, use larger implements, and prepare/cultivate more ground. **Cost: about \$8,500 (\$10,500 with bucket)**

Tillage Implements/Bed Preparation

In addition to tillage implements like a disc and subsoiler and a rotavator for bed preparation, here are some additional equipment investments to consider.

Chisel Plow: These narrow steel chisels are designed to dig deeply into and break up the soil, whether a three- or four-chisel three-point hitch mount or a hydraulic tow-behind with more chisels. They are more expensive but faster, less disturbing of soil structure, and more versatile than a moldboard plow. Use when disking is not aggressive enough and the moldboard plow is too slow or aggressive. **Cost: about \$1,000**

Field Cultivator: When a three-point tiller has to prep or till thousands of feet of beds, the wear on it can be too much. A field cultivator, whether with one or two rows of sweeps or as elaborate as the Perfecta, allows for fast bed preparation and effective post-harvest incorporation and tillage. **Cost: about \$1,250** (depending on size)

Disk Bedder: It may be worth purchasing a disk bedder for faster bed preparation. **Cost: about \$1,150**

Plastic Mulch Layer: This tool can help immensely with weed control and water conservation. Passing over a prepared 3'-4' bed, the plastic mulch layer will lay down drip tape and cover with a layer of plastic the soil you intend to plant into. Upon punching holes through the plastic at regular spacing (as with a water wheel transplanter), you then set the plants (tubers or seeds) in an environment with much reduced weed pressure, minimal soil moisture loss, and adequate water. Many transplanted crops do very well or better "on plastic." **Cost: about \$1,600**

Seeding/Planting/Transplanting Implements

If you have only spent \$140 on a push seeder to this point, here are some important investments to improve seeding and transplanting success.

Jang 2- & 3-Row Precision Push Seeder: These more expensive seeders provide much better spacing, less damage to seed, and more efficient use of seed, and they deal more easily with plant residue in the seed bed. With the \$200 three-point hitch kit, you can mount this on your tractor, making multiple or long-bed seeding much easier. **Cost: about \$1,525**

Two-Row Potato Planter: Saves significant time over planting by hand, makes the late spring planting rush easier, and increases emergence. Most models require a person on the planter, another on the tractor, and part of a third person's time keeping the potatoes supplied. **Cost: about \$1,500**

Water Wheel Transplanter: This simple, versatile tool is designed for planting through plastic and is effective on bare (especially sandy) soil. It can do multiple rows and at different in-row spacings, can deliver water and fertility at the same time, and allows for any size transplant.

The transplanter enables uniform between-row and in-row plant spacing (for better cultivation), is easier on the body than planting by hand, and usually saves on time. It requires a tractor with creeper or hydrostatic gears. **Cost: about \$3,000**

Cultivation: Between-Row

Basket Weeder (cultivating tractor mount): This tool allows for fast, delicate bed cultivation of seedlings when they are very small, helping reduce overall weed pressure and manage fine seedlings such as carrots much more easily. **Cost: about \$2,250**

Cultivation: In-Row

Finger Weeder: This unique rolling cultivator disturbs weeds in the row. Ganged with preceding sweeps or blades. **Cost (3-row set): about \$2,100**

Flame Weeder: This tool kills weeds without disturbing the soil, allowing for pre-emergence weeding of slow-germinating crops (e.g., carrots) and effective weeding of crops that suffer when physically cultivated or hand weeded. **Cost: about \$1,000**

Harvesting

One-Row Potato Harvester: A used ground drive or simpler new three-point potato digger will help immensely in bringing potatoes quickly to the soil surface for easy harvesting. **Cost: about \$500**

Salad Greens Harvester: This simple tool, powered by a cordless drill, makes it easy and efficient to harvest greens, cutting and collecting in one pass. **Cost: about \$550**

Mobile Wash/Pack Station: Adding a canopy and a small wash/pack line to a hay wagon can greatly increase produce shelf life and reduce harvesting effort. **Cost: about \$1,500**

Pest Management

While a \$125 backpack sprayer can get you a long way, at this scale, it is important for management to be able to cover much more area.

Three-Point Sprayer: Utilizing a tractor-mounted electric pump sprayer with booms, you can more easily address pest issues in your increased crop area. **Cost: \$700** (on average; \$400-\$1,000/30-110 gal.)

Irrigation/Water Source

As you increase production area, more efficient irrigation is needed, such as additional dripline and buried mainline (2" PVC with stand-up pipes) to increase water access points. **Cost: about \$1,250**

Mini Traveler: For overhead irrigation. Minimum flow rate of 10 gallons per minute and pressure of 30 PSI. Will deliver up to 12 hours of unmonitored irrigation of ¼ to ⅔ acre. **Cost: about \$1,800.** Add in the cost of a well (assumed at this point). **Cost: about \$5,000**

Greenhouse/Transplant Production House

If you are doubling the acreage you are planting (from 3–5 acres to 6–10 acres), you are going to need to double the greenhouse area to about 2,300 sq. ft. and double the germination equipment to keep up. **Cost: about \$14,500**

Vacuum Seeder: This relatively low-cost tool saves time on seeding trays and is especially effective with brassicas. **Cost: about \$800**

Wash/Pack Area

Investing substantially in a well-lit, easy-to-clean, spacious wash/pack area at this scale is necessary, both for the ease and efficiency of washing and packing but also for food safety. Depending on your markets, you may need to make this investment sooner. **Cost: \$19,470**

Walk-in Cooler

Double the cooler space of the 3–5 acre scale to about 800 cu. ft. If you are doubling what you grow, you are probably doubling the amount of cold storage needed for your harvested crops, and more space makes organizing product flows easier. Also, the cost of a cooler is a lot less than the value of the products. Looking at a used commercial cooler or an older refrigerated semi are good options. **Cost: \$3,100**

Produce Sales & Delivery

In addition to about **\$5,000** in sales equipment and materials and two delivery pickup trucks/vans (**\$12,000**), it is time to consider adding a box truck.

Box Truck (12'–14'): Purchasing one or more box or cube trucks at this point is probably necessary to move the volume you are producing, depending on your marketing strategy. These trucks will easily hold more than triple that of a pickup, often at a similar cost. **Cost: about \$7,000**

Leasing a box truck for peak season to supplement other delivery vehicles may also be necessary. **Cost: about \$1,500**

Pickup with Build Your Own Box: Many market farmers build their own 6' tall box onto a ¾-ton or 1-ton pickup to increase the amount they can carry. This is a good intermediate option that allows for a 50% or 100% increase over the amount you can carry with a pickup cap and requires careful construction.

Land

At this level of infrastructure and business investment, it would be worthwhile to own at least part if not all of the land you manage. Purchase cost for a 10-acre parcel varies greatly with proximity to urban area or water and region. Putting 20% down on a 10-acre parcel may cost about \$20,000 depending on the cost per acre, with an additional \$6,000 or so per year for a 4% 30-year mortgage. **Cost: \$25,300**

Table 4. Farming on 6–10 Acres

	Need it?	Cost*
SEEDS & SEEDLINGS		
TOTAL		\$8,000
MACHINERY & EQUIPMENT		
Tillage machines	N	-
Full-size tractors	Y	\$17,000
Cultivating tractors	Y	\$4,000
Tillage implements	Y	\$3,925
Bed preparation	Y	\$3,100
Seeding implements	Y	\$1,665
Planting/transplanting	Y	\$4,500
Cultivation: Between-row	Y	\$5,700
Cultivation: In-row	Y	\$4,060
Pest management	Y	\$825
Harvesting implements	Y	\$7,750
Construction, repair, & maintenance tools	Y	\$1,000
TOTAL		\$53,525
INFRASTRUCTURE		
Hoophouses	Y	\$15,646
Wash/pack station	Y	\$19,470
Walk-in cooler	Y	\$3,100
Water source	Y	\$5,000
Irrigation system	Y	\$3,050
TOTAL		\$46,266
PRODUCE SALES & DELIVERY		
TOTAL		\$25,470
INFORMATION, FINANCIAL, & MEDIA MANAGEMENT		
TOTAL		\$1,700
RENT/MORTGAGE		
TOTAL		\$25,300
GRAND TOTAL		\$160,261
<i>Cost of building on previous scale investments</i>		\$95,294

* Note: "Costs" represents the total investments in this category up to and including this scale, not just those from the Investments to Farm 6–10 Acres section. These costs are detailed in the Scale of Production Matrix.

➤ FARMING ON 10–20 ACRES

Farming at this scale will likely require an increase in mechanization that allows for not only labor saving but also precision in seeding, planting, and cultivating such that the tractor can do more work. Increasing the efficiency of your harvesting and wash/pack systems with designs around moving, cleaning, and packing larger quantities more quickly is critical. Finding ways to integrate mechanization from harvest through to the cooler is key. It may require scaling up your delivery vehicle. Proper training of employees, a sound management structure, good communication, and clearly understood systems for propagation/scheduling, production, post-harvest/food safety, on-farm safety, and finances are a given.

Space

500,000–1 million sq. ft. (about 5–10 soccer fields); about 200–400 beds 250 ft. long at 6 ft. spacing

Skill Level

Experienced (5+ years of experience). At this level, you need to have honed your management skills and have a management structure as well as production planning, marketing, and harvest systems in place. You should also have very good financial and record-keeping practices. In short, your farm can run as a business, and you have the capacity to guide it in the direction needed.

Time

Typically, 10–15 people can manage this scale investing 40 hours per week on average for a mostly direct market sales farm, or less with higher mechanization/standardization. A high level of experience is also needed from managers and crew leaders to stay at peak efficiency. Managers will need to put in 50 hours per week and sometimes more during peak production, from late July through early September. This of course depends on the intensity, crop type, and equipment used.

Production Value/Sales

You could expect from \$100,000 (about \$10,000/acre) on the very low end up to \$500,000–\$600,000 (\$25,000–\$30,000/acre) in sales on the higher end, and more likely \$150,000–\$450,000 on average, depending on acreage, crop type, markets, and experience. It is unlikely that you would achieve high-end sales in your first years on a piece of land or community as you learn the soil and landscape, develop production systems, and build name recognition.

Profit/Income

While profit can vary wildly, one could expect somewhere between 10%–40% profit (profit = sales – expenses), which could be in the range of \$15,000–\$180,000.

Infrastructure & Equipment Costs

About \$320,000 (range: \$250,000–\$400,000 range) if you are starting at this level, or **about \$160,000** if applying investments from farming 6–10 acres to this scale. These are detailed below and in the *Scale of Production Matrix*.

Cash Flow

You need to plan for having upwards of six weeks of payroll in cash reserves at this time. This can be carryover from the prior year, up-front payments from larger accounts, “farm share” (CSA) sales, or a bridge loan, if needed. By late July/August, sales of summer crops can result in increasing sales that can balance labor costs.

Land Ownership/Rental

At this scale, it is very important to own your land or have a long-term lease to protect the core of your operation (where most of your infrastructure is located) and have very clear legal protections of your investments in the lease, whether you lease all of your land or only some outlying fields. For farms that are organic certified, longer leases will be important. (See resources given in the Land Ownership/Rental section on page 10.)

CASE STUDY 5

With 10 years of farming experience at various types of smaller farms before starting, this husband-and-wife team began farming on about 3 acres of leased land in 2006, selling to 50–60 CSA members and a few farmers markets and specialty stores. In 2008, with the very generous help of a land-owning CSA member, they were able to purchase land and start their own farm. That year they had 80–100 CSA members, attended a few area farmers markets, and were building relationships with specialty retailers. The land had no structures—they built a home, outbuildings, and all the infrastructure they have today.

If you visit their farm, it may be hard to believe that they had nothing when they first started. They have had to purchase and build two season extension hoophouses, a 40' x 80' wash/pack facility (the upgrade from their first wash/pack area), two full-size tractors with buckets and forks, one or two cultivating tractors,

a walk-in cooler (bought from a store going out of business), a refrigerated box truck, various cultivators, a water wheel transplanter, chisel plow, field cultivators, 3-point rototiller, and so on. One of the best decisions besides the improved wash/pack building was a \$35,000 microloan they got in 2013 or so to get the reefer truck, water wheel transplanter, the second big tractor, and a few other items. It really boosted their capacity at a critical time. While these farmers have taken out numerous loans to support their growth, a choice some may find risky, they consider these decisions essential to the vision they have for the farm.

Today, the farm has over 20 acres in vegetable production and vegetable sales well over \$400,000 annually. The farmers go to six farmers markets, have about 300 CSA members, and do over \$150,000 in wholesale sales to retail, restaurants, food hubs, and distributors in the area.

Investments to Farm 10–20 Acres

Seeds & Seedlings

You will have increased seed and soil mix costs, and you are going to want additional heat mats or germination chamber space for Solanaceae and other warmth-loving seedlings. **Cost: about \$12,000**

Machinery

A large third tractor and a second cultivating tractor will be needed, in addition to the tractors needed at the previous scale.

Third Tractor: Adding an 85+ HP 2WD tractor or a 65+ HP 4WD tractor is essential. Being able to pull larger implements for tillage, bed preparation, and cultivation and more mechanized harvesting is critical for efficiency. Having the tractor sized for moving pallets of product into and out of the wash/pack area may also be important. **Cost: \$50,000** (new 4WD 65 HP tractor)

Second Cultivating Tractor: Depending on your system, adding this may also be essential. **Cost: about \$13,000**

Bed Preparation

Finishing Cultivator: Using multiple components on the tool frame, this implement allows for making a fine-textured bed with one pass. **Cost: about \$3,000** (new 80" Perfecta)

Bed Shaper/Former: Precision seeding, transplanting, and especially cultivation is much more effective with level, uniform beds. **Cost: about \$1,500**

Seeding

Three-Point Multi-Row Seeder: This tractor-mounted seeder is made of more durable materials than a push seeder and will handle many acres of seeding. **Cost: about \$3,000**

Transplanting

Three-Point Transplanter: When adapting a water wheel transplanter to bare soil is not working, a traditional or carousel type transplanter may be what you need. Find one with the most flexibility on spacing and plug size. **Cost: about \$3,000** (two-row transplanter)

Cultivation: Between-Row

Multi-Tool Weeding Frame: This three-point frame combining three or four types of cultivating components (spring hoes, S/C-tines, Spydors, sweeps, etc.) allows for more effective weed killing and over a broader range of weed sizes in one pass. **Cost: about \$4,000**

Cultivation: In-Row

Three-Point Flexline Weeder: An implement that allows for pre- and early post-emergent weed management of many seeded crops and transplants across the entire bed surface, in and between rows. **Cost: about \$2,500**

Three-Point Flame Weeder: A step up from the push or backpack flamer for flaming much more ground. **Cost: about \$3,350**

Harvesting Equipment

Two-Row Potato Harvester: If you are planting acres of potatoes, this implement will improve harvest speed and quality immensely. **Cost: about \$6,500** (You may be able to find a used one for far less if you are lucky; new ones are often \$9,000+.)

Tools

Having a complete set of power tools and hand tools for building, maintaining, and repairing infrastructure and equipment is essential. At this scale, with the amount of equipment and machinery needed, having a welder, a metal bender, a table saw, and other fabricating and repair equipment is necessary. Having someone who manages maintenance on equipment as part of their responsibility is going to be important too. **Cost: \$2,000** (new and used)

Irrigation/Water Source

Full-Size Traveler: Stepping up from a mini traveler may be very helpful for irrigating more area. **Cost: \$10,000**

Irrigation Pond: To support a larger water demand, capacity can be increased by installing an irrigation pond. **Cost: \$3,750** (range: \$2,500–\$5,000)

Solid Set Irrigation: Adding this, with stand-up sprinkler heads, can help as well. **Cost: \$1,500** (1,000 ft.)

Hoophouse/Greenhouse

As you increase transplant production, you will need more space, perhaps spending another **\$8,000** on added greenhouse infrastructure and heating.

Wash/Pack Area

Similarly, you may need to spend **about \$8,000** to build increased wash/pack capacity to maintain or improve efficiency with greater production.

Refrigeration

At this scale, having a robust, reliable commercial refrigeration unit and perhaps a used commercial cooler room may be a worthy investment. **Cost: \$4,750**

Produce Sales & Delivery

Depending on how much you need to deliver at any one time, in addition to your existing fleet of vehicles, you may need to move up to a larger (20'–24') used box truck. **Cost: about \$12,500**

Information, Financial, & Media Management

While many standard information and financial management tools have probably worked well to this point, it is worth looking into more specialized tools that would improve efficiency if they are cost effective.

Table 5. Farming on 10–20 Acres

	Need it?	Cost*
SEEDS & SEEDLINGS		
TOTAL		\$12,000
MACHINERY & EQUIPMENT		
Tillage machines	N	-
Full-size tractors	Y	\$72,000
Cultivating tractors	Y	\$17,000
Tillage implements	Y	\$3,295
Bed preparation	Y	\$7,600
Seeding implements	Y	\$3,140
Planting/transplanting	N	\$7,500
Cultivation: Between-row	Y	\$10,700
Cultivation: In-row	Y	\$6,450
Pest management	Y	\$825
Harvesting implements	Y	\$18,250
Construction, repair, & maintenance tools	Y	\$2,000
TOTAL		\$149,390
INFRASTRUCTURE		
Hoophouses	Y	\$22,330
Wash/pack station	Y	\$27,220
Walk-in cooler	Y	\$6,250
Water source	Y	\$8,750
Irrigation system	Y	\$13,675
TOTAL		\$78,225
PRODUCE SALES & DELIVERY		
TOTAL		\$28,470
INFORMATION, FINANCIAL, & MEDIA MANAGEMENT		
TOTAL		\$1,700
RENT/MORTGAGE		
TOTAL		\$50,600
GRAND TOTAL		\$320,385
<i>Cost of building on previous scale investments</i>		\$157,074

* Note: "Costs" represents the total investments in this category up to and including this scale, not just those from the Investments to Farm 10–20 Acres section. These costs are detailed in the Scale of Production Matrix.

» APPENDIX A: INTRODUCTION TO THE SCALE OF PRODUCTION MATRIX TABLES

Layout Guide: Index to the Scale of Production Matrix

Similar to this document, *Sizing Up Diverse Vegetable Farms*, the companion piece, *Scale of Production Matrix*, explores the various areas of infrastructure and equipment investment in a working farm at different sizes. This document is organized by farm size (scale), but the information in the Matrix is organized by equipment and infrastructure types, reflecting the possible needs at different scales. The Summary Table aggregates the cost information for each scale detailed in Tables 1–8 (listed below). These detailed tables offer suggestions for potentially appropriate choices of equipment, infrastructure, or other investments for each scale. In Table 9, we explore some possible funding options for different scales. Farmers can also download an Excel version of the Matrix at msuorganicfarm.org/resources to modify as they choose and build their own draft infrastructure budget.

SCALE OF PRODUCTION MATRIX	
SECTION	DESCRIPTION
Summary Table	Summarizes the total cost estimates by scale (size of farm) for Tables 1–8
1: Tractors	Tractors, walking tractors, and cultivating tractors by scale (size of farm)
2: Tillage to Transplanting	Implements and equipment for tillage, bed preparation, direct seeding, and transplanting
3: Cultivation	Implements and equipment for cultivation
4: Harvest & Pest Mgmt.	Implements and equipment for harvesting and pest management
5: Infrastructure	Infrastructure: Hoophouse, wash/pack area, and coolers
6: Water & Irrigation	Infrastructure: Water and irrigation
7: Sales, Delivery, & Mgmt. Tools	Equipment, tools, and vehicle needs for sales, delivery, and business management
8: Land	Cost considerations around land
9: Funding Sources	Potential sources of financial assistance or funding for investment capital
References & Sources	Sources and calculations for many costs and estimates used

Items, Descriptors, and Costs

The left side of each table lists the items appropriate for each table category with some very brief descriptors (“USED,” “2-row,” etc.). To the right is the likely range of costs for that item based on our research and an average cost. *Note:* There may be items missing from this list or items priced differently or named differently from what you would call them based on regional preferences. Consider this an opportunity to edit and improve the tool.

Scale Headings

Across the top are the different scales: “Less Than 1 Acre,” “1–2 Acres,” and so on. Each scale category then provides the options “Do You Need It?” “How Many?” and “Cost.”

Prioritizing Items at Different Scales

“Do you need it?” There are many answers to this question; here is a key to how we have answered it.

Yes (Y)—This assumes you need the item.

Example: In Table 1, look at the third item under Machinery & Equipment, “Walk-behind tractor,” and go across to “Less Than 1 Acre.” There is a “Y” in the “Do You Need It?” column, a 1 in the “How Many?” column, and a number for the average cost, \$850, in the “Cost” column.

Very Helpful (VH)—You may consider getting this item as it could be cost effective at this scale, but it isn’t critical.

Helpful (H)—This is an optional item. It could be helpful, but the benefit really doesn't justify the cost at this point.

Maybe (M)—This is not really a cost issue but a strategy issue. For example, under Irrigation, you may find cheap overhead sprinklers handy and workable for your system if you have decent water pressure, or you might just use drip tape for everything, or you might use solid set irrigation.

No (N)—This is just not worth the investment for this scale, given the many other places you could spend the money. *Note:* These are not rules but a guide, our suggestions, and you may answer these questions differently based on your farm, your experience, your preference, and so on.

How Many of This Item Do You Need?

We have made some estimates of how many of an item you might want to consider having, based on our research, but of course you may want or need more or less based on how you run your operation. Again, these numbers are just a starting point for evaluating and planning as you grow or change your operation. For some items, such as the in-row cultivation tools, we use per-row set costs so that you can look at building your own rather than purchasing an entire built three-point toolbar rig. With some of the infrastructure, such as cooler or hoop house space, we provide a cost per square foot or cubic foot so that you can estimate based on different needs at different scales.

Cost

This is a product of the average cost for the item and the quantity needed. The total of all the costs for your scale is summed at the bottom of each individual page/table and in the Summary Table. These costs may not reflect items in your area or at a particular time of year.

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Center for Regional Food Systems
Michigan State University

480 Wilson Road
Natural Resources Building
East Lansing, MI, 48824

For general inquiries:

LEARN: foodsystems.msu.edu

EMAIL: CRFS@anr.msu.edu

CALL: 517-353-3535

FOLLOW: @MSUCRFS

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