"Comparing and teaching small and micro farming scales for beginning farmers"

By Organic Farm School and Oxbow Farm staff

WSDA Specialty Crop Block Grant Project # K2857 - Final Report

Introduction:

At the Organic Farm School (OFS, Clinton, WA), students are aspiring farmers who come to study and practice methods of small-scale fresh vegetable production, direct marketing and community engagement. Most of these students hope to one day start and manage a small-farm and are seeking the skills and knowledge that will enable them to do so.

These aspiring farmers will likely face numerous challenges in starting a new farm business including finding access to farmland and capital. Farming can be a difficult business to enter with the cost of land and traditional infrastructure and equipment all very high, often causing aspiring farmers to feel daunted by this situation. Over the past decade, several high-profile small market farms have promoted intensive farming methods of specialty crops using only two-wheeled tractors and hand labor while claiming to be profitable and sustainable on under two acres of production. Often called micro-farming, this model is very appealing to new farmers who see it as an opportunity to enter farming with significantly reduced land and equipment investments, thus increasing their chances at successfully launching a new farm business.

To help the students at the OFS determine if this style of farming was a viable option for them, the OFS, through this project, added a 1/3 acre "micro-farm" style production to the existing 10 acres of "traditional" four-wheel tractor production already in use, to experience and compare these two methods. Project partner Oxbow Farm (Carnation, WA) also added micro-farm style production to their operation to develop a second set of comparison observations to this project. This report shares the observations made over the past three seasons of implementing these two methods at both farms.

Project goals:

To help new farmers assess whether a "micro-farming" system would be appropriate for a new farm start-up, this project sought to report on:

- A comparison of the labor and costs required to produce crops using each method.
- A comparison of the yields, health and outcomes of crop production using each method.
- A comparison of start-up equipment costs between a "micro-farm" using two-wheeled tractors and a "small-farm" using four-wheeled tractors.
- A reflection of the experience, by farmers, of comparing the two methods.

Project methods summary:

Farm Managers at both the OFS and Oxbow Farm identified 0.3 acres of land to implement micro-farming practices and then read J.M. Fortier's book, "The Market Gardener", which is one of the most popular books promoting micro-farming methods, to develop specific plans on applying these methods. Appropriate tools and supplies needed were acquired and the gardens were created in the spring of 2020. As comparing labor requirements was a major focus of the

project, time-studies for each farm activity were planned and logged. A time-study is the logging of the time taken to accomplish a specific farm task. Each activity was logged several times and averages were developed for each task.
Three representative crops were chosen (bunched kale, bunched radishes and salad mix) and farmers recorded crop yields as harvests occurred and made observations on soil and crop health along with a general assessment of the pros and cons of each method. OFS students were trained in both methods of farming and interviewed for their observations and reflections on comparing the two methods.

Challenges and Limitations of the project:
There were many challenges and limitations encountered in this project, and many seem to be inherent in the work itself, as the nature of farming includes a wide number of variables, the work required for any specific crop is ever-changing and each farm is uniquely designed and managed. As a result, the numbers and conclusions drawn from this project seem most valuable viewed as unique examples and not necessarily reflective of small or micro-farms in general. We realize that other farms would likely come up with different numbers and conclusions but despite this lack of reliable consistency, the results of this project still offer insights through its example and should encourage others to further study this question and share their specific results.
Some key limitations we encountered included:

- We only performed time studies on activities that were most different between the two farming systems, namely bed preparation, planting and weed management. Other farm activities, including irrigation, other pest management and harvest and post-harvest handling, were, on these farms, essentially similar. This would not always be the case in studying other farms.
- Because not all aspects of crop production were tracked, we needed to estimate the costs of other production activities. To do this, we used data developed by Richard Wiswall in his book, "*The Organic Farmer's Business Handbook*"(2012). Wiswall's crop budgets seemed to be the most applicable as they are based on an organic, small scale farm system (five acres). To account for inflation since 2009 (when the budgets were developed), all published costs used were multiplied by 1.31 (to reflect the 31% inflation from 2009-2022) to better match current costs.
- For some of the tasks that were included in this project, the efficiency of the small-farm/four-wheel tractor method was limited by the current investment and availability of implements at both project farms. Certain tasks that could be further mechanized, such as spreading compost, transplanting, and in-row weeding, had not yet been mechanized. Had they been, there would likely be an increase in labor/time savings of the small-farm plots as well as the potential for increasing scale if desired.

Project Methods:
<u>Labor comparison and crop production costs</u>:
One key objective was to compare the labor requirements between the two methods of farming. Farmers started by listing the steps and activities of production in each method and then logging the average time required for each step/activity. Most tasks were logged as

minutes per bed and then extrapolated to hours per acre. If the task used a machine or tool, the cost of that machine/tool was also determined and included.
Once production activities had an average time and cost assigned to them, three representative crops were selected to determine crop costs. The three crops selected were bunched kale, bunched radishes and salad mix (grown using the newer one-cut head lettuce varieties). For each crop, a count of each production activity was determined and used to multiply against the cost of that activity. This project only determined the costs for bed preparation, planting and weed management which, in an evaluation of several published crop budgets, was found to generally be 20% of the total crop production cost.
A summary of the results is shown below (Tables 1 and 2) and detailed activity costs and crop costs for both methods at both farms are shown in the eight tables included in the appendix:

Micro-Farm Crop Costs per acre:

** Only bed preparation, planting and weed control costs included*

	KALE		RADISH		SALAD MIX	
	Hours of Labor	Total Cost: Labor + Equip	Hours of Labor	Total Cost: Labor + Equip	Hours of Labor	Total Cost: Labor + Equip
OFS:						
Bed preparation	*76*	*$ 2,642.92*	*76*	*$ 2,642.92*	*76*	*$ 2,642.92*
Planting	*54*	*$ 1,195.75*	*10*	*$ 304.96*	*54*	*$ 1,195.75*
Weed control	*89*	*$ 1,976.45*	*28*	*$ 619.53*	*89*	*$ 1,976.45*
Total per acre:	**219**	**$ 5,815.12**	**114**	**$ 3,567.41**	**219**	**$ 5,815.12**
Oxbow:						
Bed preparation	*103*	*$ 3,059.71*	*103*	*$ 3,059.71*	*103*	*$ 3,059.71*
Planting	*45*	*$ 996.46*	*9*	*$ 277.23*	*45*	*$ 996.46*
Weed control	*79*	*$ 2,099.28*	*90*	*$ 1,992.92*	*79*	*$ 2,099.28*
Total per acre:	**227**	**$ 6,155.44**	**202**	**$ 5,329.86**	**227**	**$ 6,155.44**

Table 1. Micro-Farm labor and equipment costs for three crops at two separate farms.

Small-Farm Crop Costs per acre:

** Only bed preparation, planting and weed control costs included*

	KALE		RADISH		SALAD MIX	
	Hours of Labor	Total Cost: Labor + Equip	Hours of Labor	Total Cost: Labor + Equip	Hours of Labor	Total Cost: Labor + Equip
OFS:						
Bed preparation	*27*	*$ 993.79*	*27*	*$ 993.79*	*27*	*$ 993.79*
Planting	*22*	*$ 481.62*	*3*	*$ -*	*22*	*$ 481.62*
Weed control	*80*	*$ 1,870.26*	*56*	*$ 1,237.90*	*80*	*$ 1,870.26*
Total per acre:	**128**	**$ 3,345.67**	**86**	**$ 2,231.69**	**128**	**$ 3,345.67**
Oxbow:						
Bed preparation	*4*	*$ 311.42*	*4*	*$ 311.42*	*4*	*$ 311.42*
Planting	*40*	*$ 885.74*	*2*	*$ 123.32*	*40*	*$ 885.74*
Weed control	*69*	*$ 1,643.87*	*1*	*$ 98.26*	*68*	*$ 1,602.69*
Total per acre:	**113**	**$ 2,841.03**	**8**	**$ 533.00**	**112**	**$ 2,799.85**

Table 2. Small-Farm labor and equipment costs for three crops at two separate farms.

Production activities:

Each farm in the project determined its own selection and order of production activities, and activities differed at each farm. Activities performed at each farm (for bed preparation, planting and weed management) are listed in the four tables below, two for each farm and method.

Micro-Farm Activities: OFS

	KALE	RADISH	SALAD MIX
	Activity Count		
Bed preparation			
Flail Mow	1	1	1
Rotary plow to raise beds	0.5	0.5	0.5
Cover w/ silage tarps	1	1	1
Remove silage tarps	1	1	1
Broadfork	1	1	1
Spread compost	1	1	1
Spread fertilizer	1	1	1
Power harrow	1	1	1
Raking	1	1	1
Planting			
Direct-seeding	0	1	0
Transplanting	1	0	1
Weed control			
Flame weeding	1	1	1
Hand hoeing	2	1	2
Hand weeding	1	0	1

Micro-Farm Activities: Oxbow

	KALE	RADISH	SALAD MIX
	Activity Count		
Bed preparation			
Flail mow	1	1	1
Rotary plow to raise beds	0.5	0.5	0.5
Cover w/ silage tarps	1	1	1
Remove silage tarps	1	1	1
Broadfork	1	1	1
Spread compost	1	1	1
Spread fertilizer	1	1	1
Power harrow	1	1	1
Planting			
Direct-seeding	0	1	0
Transplanting, hand	1	0	1
Weed control			
Hand hoeing	0	1	0
Hand weeding	1	1	1
Landscape fabric install	1	0	1
Landscape fabric removal	1	0	1

Small-Farm Activities: OFS

	KALE	RADISH	SALAD MIX
	Activity Count		
Bed preparation			
Mow	1	1	1
Disc	3	3	3
Chisel plow	0.5	0.5	0.5
Spread fertilizer	1	1	1
Spread compost	1	1	1
Shape beds	1	1	1
Planting			
Direct-seeding	0	1	0
Transplanting	1	0	1
Weed control			
Tractor weeding	1	0	1
Flame weeding	1	1	1
Hand hoeing	2	1	2
Hand weeding - in-row	1	1	1

Small-Farm Activities: Oxbow

	KALE	RADISH	SALAD MIX
	Activity Count		
Bed preparation			
Mow	1	1	1
Disc	2	2	2
Chisel plow	0.5	0.5	0.5
Spread fertilizer	1	1	1
Power harrow	1	1	1
Shape beds	1	1	1
Planting			
Direct-seeding	0	1	0
Transplanting	1	0	1
Weed control			
Tractor weeding	1	1	1
Hand hoeing	1	0	1
Wheel hoeing - w/ finger weeder	1	0	1
Path cultivation w/ tractor	2	1	1

Labor costs:

The hourly cost of labor (Table 3) was calculated as a composite of four employees; one manager paid at $25/hr and three field crew members at $15/hr. Taxes, workers compensation insurance and non-assigned time were also included (non-assigned time reflects the work time required to transition to and prepare for tasks).

Estimated Cost of Labor

	Manager	Field crew	Composite crew 1:3
Est. hourly rate:	$ 25.00	$ 15.00	$ 17.50
Employee taxes: 7.73%	$ 1.93	$ 1.16	$ 1.35
Workers' comp: 2.3%	$ 0.58	$ 0.35	$ 0.40
Nonassigned time: 15%	$ 4.13	$ 2.48	$ 2.89
Labor costs/hour:	**$ 31.63**	**$ 18.98**	**$ 22.14**

Table 3. Estimated hourly costs of labor.

Equipment costs:

Four budgets were developed (including low and high cost estimates for both micro and small-farm styles) to estimate of the cost of assembling a basic set of farm production equipment (for bed preparation, planting and weeding). Specific activity equipment costs were determined using an average purchase price of the low and high cost estimates and then calculated using the Machinery Cost Calculator developed by Rob Gamble at OMAFRA, Guelph, Ont. The calculator figured per hour costs using factors including life, purchase price, trade-in value, interest rate, depreciation, insurance, fuel use, maintenance and repairs. Hours per year were estimated using an average of the two farm's time study data (see Table 4).

Estimated Cost of Equipment (For bed preparation, planting and weed control)

Micro-Farm - Low Cost (Budget New)		Micro-Farm - High Cost (Upgraded New)		AVG. cost	Life (yrs)	Est. hrs/yr*	Cost/hr**	Cost/yr
BCS 732***	$ 3,350.00	BCS 749***	$ 5,187.00	$ 4,268.50	12	50	$ 11.54	$ 577.00
Power Harrow, 30"	$ 2,400.00	Power Harrow, 30"	$ 2,400.00	$ 2,400.00	10	9	$ 39.60	$ 356.40
Rotary Plow	$ 1,550.00	Rotary Plow	$ 1,550.00	$ 1,550.00	10	12	$ 19.18	$ 230.16
Flail Mower 18"	$ 1,300.00	Flail Mower 30"	$ 2,375.00	$ 1,837.50	10	14	$ 14.76	$ 206.64
landscape rake	$ 100.00	landscape rake	$ 100.00	$ 100.00	7	50	$ 0.25	$ 12.50
broadfork	$ 230.00	broadfork	$ 240.00	$ 235.00	7	100	$ 0.29	$ 29.00
Silage tarp (1 ac, 4 uses/yr)	$ 4,320.00	Silage tarp (1 ac, 4 uses/yr)	$ 4,320.00	$ 4,320.00	5	4	$ 259.20	$ 1,036.80
wheelbarrow	$ 150.00	wheelbarrow	$ 150.00	$ 150.00	7	50	$ 0.41	$ 20.50
single row push seeder	$ 500.00	3 row push seeder	$ 950.00	$ 725.00	10	10	$ 8.66	$ 86.60
		paperpot transplanter	$ 3,000.00	$ 1,500.00	10	50	$ 8.90	$ 445.00
Stirrup hoe	$ 60.00	Stirrup hoe	$ 60.00	$ 60.00	7	100	$ 0.08	$ 8.00
Landscape fabric (1 ac, 2 uses/yr	$ 2,879.28	Landscape fabric (1 ac, 2 uses/yr)	$ 2,879.28	$ 2,879.28	5	2	$ 345.51	$ 691.02
Total	***$ 16,839.28***	***Total***	***$ 23,211.28***	***$ 20,025.28***	***Avg.***		***Total***	***$ 3,699.62***
% of S.F.L.C.:	*33%*	*% of S.F.H.C.:*	*24%*	***$ 4,625.27***	***annual loan payment @ 5% over 5 years***			

Small-Farm - Low Cost (Budget New + used)		Small-Farm - High Cost (Upgraded New)		AVG. cost	Life (yrs)	Est. hrs/yr*	Cost/hr**	Cost/yr
50hp tractor w/loader - used	$ 25,000.00	50hp tractor w/loader - new	$ 37,000.00	$ 31,000.00	15	250	$ 30.71	$ 7,677.50
budget new power harrow	$ 3,500.00	heavy duty power harrow	$ 9,500.00	$ 6,500.00	12	10	$ 68.90	$ 689.00
used 5' chisel plow	$ 1,500.00	new 5' chisel plow	$ 3,000.00	$ 2,250.00	12	5	$ 46.13	$ 230.65
used 5' disc	$ 1,000.00	new 5' disc	$ 3,000.00	$ 2,000.00	12	28.0	$ 7.05	$ 197.40
budget flail mower 60"	$ 2,500.00	heavy duty flail mower 60"	$ 7,000.00	$ 4,750.00	12	22	$ 22.89	$ 503.58
budget bed shaper	$ 3,000.00	heavy duty bed shaper	$ 4,000.00	$ 3,500.00	12	11	$ 31.29	$ 344.19
Between-row cultivator	$ 3,000.00	In-row/between-row cultivator	$ 10,000.00	$ 6,500.00	12	45	$ 15.65	$ 704.25
used conespreader	$ 500.00	new conespreader	$ 900.00	$ 700.00	12	20	$ 3.44	$ 68.80
used manure spreader	$ 5,000.00	new manure spreader	$ 10,000.00	$ 7,500.00	12	20	$ 37.50	$ 750.00
3 row hole seeder w/tool bar	$ 3,500.00	3 row vacuum seeder w/tool bar	$ 7,000.00	$ 5,250.00	12	10	$ 51.23	$ 512.30
used wheel transplanter	$ 2,000.00	new wheel transplanter	$ 3,500.00	$ 2,750.00	12	25	$ 10.82	$ 270.50
simple wheel hoe	$ 350.00	premium wheel hoe	$ 1,000.00	$ 675.00	10	100	$ 0.69	$ 69.00
path cultivator	$ 500.00	path cultivator	$ 1,500.00	$ 1,000.00	12	10	$ 9.83	$ 98.30
Total	***$ 51,350.00***	***Total***	***$ 97,400.00***	***$ 74,375.00***	***Avg.***		***Total***	***$ 12,115.47***
% of M.F.L.C.:	*305%*	*% of M.F.H.C.:*	*420%*	***$ 17,178.75***	***annual loan payment @ 5% over 5 years***			

** assuming 2 ac for MF and 10 ac for SF*

*** as determined using a Machinery Cost Calculator developed by Rob Gamble at OMAFRA, Guelph*

**** as an example of typical commercial 2-wheel tractors*

Table 4. Estimated equipment costs for bed preparation, planting and weeding.

Yield data:

Project farms kept yield records from the selected crops for both the micro and small-farm methods. The comparison of small-farm to micro-farm yields is shown as a percentage. While the two methods showed no difference in yield at the OFS, there was a significant difference in yield at Oxbow Farm with the small-farm yielding less than half of the micro-farm (Table 5).

Crop Yield Comparison:

MF = Micro-farm, SF = Small-farm

Crop	**Kale**	**Radish**	**Salad Mix**
Unit	Bunch	Bunch	Pound
OFS:			
MF Yield per acre	23760	11124	9720
SF Yield per acre	23577	11223	9831
SF yield/MF yield (%)	99%	101%	101%
SF yield/MF yield (% avg.)	100%		
Oxbow:			
MF Yield per acre	15768	24192	6296
SF Yield per acre	9100	10260	2740
SF yield/MF yield (%)	58%	42%	44%
SF yield/MF yield (% avg.)	48%		
Combined average:	74%		

Table 5. Crop yield comparisons for three crops at two separate farms.

Results:

Soil and Crop Health:

Farmer observations on crop and soil health did not reveal significant differences in crop health but did observe less compaction, less weed pressure and generally improved tilth in the soil of the micro-farm beds. Oxbow Farm noticed more soil life in the micro-farm plot, but that plot had been fallowed prior to the project which may have been the cause. The reduced capability to grow high-biomass cover crops in the micro-farm was also a concern for long-term soil health management. A comprehensive soil quality test taken from the two plots at the OFS at the end of the project did show increased soil respiration in the micro-farm plot which is a direct measurement of biological activity. The coarser textured soil in the small-farm plot may also be a contributing factor to the lower respiration and lower available water holding capacity. Extractable P, K and additional nutrients were also slightly lower in the small-farm as compared to the micro-farm plot. Both methods resulted in an overall soil quality rating of *Very High* (Fig. 1).

Comprehensive Assessment of Soil Health Organic Farm School, Whidbey Island, WA

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences

4-Wheel Tractor "Small Farm"

Measured Soil Textural Class: **sandy loam**

Sand: **72%** - Silt: **16%** - Clay: **10%**

Group	Indicator	Value	Rating
physical	Predicted Available Water Capacity	0.18	77
physical	Aggregate Stability	71.8	91
biological	Organic Matter Soil Organic Carbon: 4.42 / Total Carbon: 4.43 / Total Nitrogen: 0.23	6.6	99
biological	ACE Soil Protein Index	18.2	99
biological	Soil Respiration	0.3	18
biological	Active Carbon	698	89
chemical	Soil pH	6.4	100
chemical	Extractable Phosphorus	2.7	77
chemical	Extractable Potassium	173.6	100
chemical	Additional Nutrients Ca: 881.7 / Mg: 159.3 / S: 20.9 Al: 259.8 / B: 0.33 / Cu: 0.08 Fe: 25.6 / Mn: 4.4 / Zn: 1.3		77

Overall Quality Score: **83** / Very High

2-Wheel BCS Tractor "Micro-Farm"

Measured Soil Textural Class: **sandy loam**

Sand: **61%** - Silt: **27%** - Clay: **11%**

Group	Indicator	Value	Rating
physical	Predicted Available Water Capacity	0.24	94
physical	Aggregate Stability	72.0	91
biological	Organic Matter Soil Organic Carbon: 5.32 / Total Carbon: 5.33 / Total Nitrogen: 0.31	7.7	100
biological	ACE Soil Protein Index	22.1	99
biological	Soil Respiration	0.6	45
biological	Active Carbon	935	99
chemical	Soil pH	6.8	100
chemical	Extractable Phosphorus	6.9	100
chemical	Extractable Potassium	446.2	100
chemical	Additional Nutrients Ca: 2048.8 / Mg: 563.4 / S: 18.8 Al: 126.2 / B: 1.02 / Cu: 0.11 Fe: 9.5 / Mn: 2.6 / Zn: 2.2		88

Overall Quality Score: **92** / Very High

Fig. 1. Comprehensive assessment of soil health comparing the small farm to the micro-farm methods at the Organic Farm School.

Labor and Cost Comparisons:

For bed preparation, planting and weeding activities, the small-farm method took, on average, 49% of the labor hours than that of the micro-farm method, and the costs per acre were 47%. Once other farm activities and overhead were factored in however, the cost per acre averaged at 67% (see Table 6).

Labor and Cost Comparisons

MF = Micro-farm, SF = Small-farm

**Only bed preparation, planting and weed control costs included*

	OFS avg.	Oxbow avg.	Avg.
MF Labor hours per acre*	184	219	201
SF Labor hours per acre*	114	78	96
SF Labor/MF Labor (%)	62%	35%	49%
MF Crop cost per acre*	$ 5,065.88	$ 5,880.25	$ 5,473.07
SF Crop cost per acre*	$ 2,974.34	$ 2,057.96	$ 2,516.15
SF cost/MF cost (%)	59%	35%	47%

Table 6. Average labor and cost comparisons at two separate farms.

Potential Profit comparisons:

Using averaged data from both farms as well as data from Wiswall (2012), we projected four scenarios of farm profitability; including both methods at two acres and 5.6 acres. Some estimates used in creating these projections include additional production costs not included in the time studies, overhead costs and potential sales. Additional production costs include supplies, harvest, post-harvest handling and marketing costs, all based on averages from Wiswall data. Overhead costs were also estimated based on Wiswall data. Potential sales were determined using a base rate of $50,000 per acre in retail sales of high-value crops for the 2-acre micro-farm and a yield reduction of 26% for the small-farm (based on project yield data). For the 5.6-acre farms, potential sales were figured assuming 50% of total sales at 50% pricing to reflect the likelihood of the higher total volume being sold partially to wholesale markets (see Table 7).

Potential Profit Comparison

MF = Micro-farm, SF = Small-farm

Acreage	2 acres		5.6 acres	
Farming Method	**MF**	**SF**	**MF**	**SF**
Project Costs/acre	$ 5,473.07	$ 2,516.15	$ 5,473.07	$ 2,516.15
Additional production costs/acre*	$ 13,000.00	$ 13,000.00	$ 13,000.00	$ 13,000.00
Total Production Cost/acre:	$ 18,473.07	$ 15,516.15	$ 18,473.07	$ 15,516.15
Total overhead costs*	$ 20,000.00	$ 20,000.00	$ 25,000.00	$ 25,000.00
Acres worked	2	2	5.6	5.6
Overhead cost/acre	$ 10,000.00	$ 10,000.00	$ 4,464.29	$ 4,464.29
Total cost/acre	$ 28,473.07	$ 25,516.15	$ 22,937.35	$ 19,980.44
SF/MF Total cost/acre: %		90%		87%
Potential Total Yield ratio	1	0.74	2.8	2.08
Potential Sales/acre**	$ 50,000.00	$ 37,075.10	$ 37,500.00	$ 27,806.33
Potential Sales total	$ 100,000.00	$ 74,150.20	$ 210,000.00	$ 155,715.42
Total Expenses (cost/ac x acres)	$ 56,946.13	$ 51,032.30	$ 128,449.17	$ 111,890.44
Net Profit	$ 43,053.87	$ 23,117.90	$ 81,550.83	$ 43,824.98

* based on data from R.Wiswall

** based on: 1) SF yield = 74%

2) 2ac = 100% retail sales, 5.6ac = 50% retail sales + 50% wholesale sales

Table 7. Potential profit comparisons of a two-acre micro-farm and two sizes of small farms.

Discussion:

Production Cost and Labor:

Based on this project's data, and additional estimates using data from Wiswall (2012), the micro-farm showed higher profitability than the small-farm method. Despite the fact that micro-farm costs were 10-13% higher due to labor, because of a reduction in yield of 26% on the small-farm, the micro-farm maintained higher net profitability.

It is important to remember that if the small-farm is able to match the yields of the micro-farm (as it did in the OFS project data), then the small-farm model becomes more profitable. In addition, the small-farm method was not fully optimized and there were unrealized potential time and cost savings in spreading fertilizer and compost, transplanting and in-row weed cultivation. It would be interesting in a future project to compare the two methods including those small-farm efficiencies.

While many new farmers might see the current results as a recommendation toward the micro-farm model, there are many pros and cons in each method to consider before making a choice of farm models. As with many things farming, a general recommendation cannot be made as many factors need to be considered and what is best in one situation may not necessarily be best in another. Additional factors for a beginning farmer to consider when evaluating these two methods include:

- Land Access: The small-farm method requires access to additional land.
- Capital Access: The small-farm method requires access to additional investment capital. As shown in the equipment budget chart (Table 4), initial equipment investments (for bed preparation, planting and weeding) could be $20,025 for the micro-farm and $74,375 for the small-farm. Annual payments for these amounts would be $4,626 for the micro-farm and $17,179 for the small-farm (for a difference of $12,553 annually), both based on a five-year, 5% interest loan.
- Equity: The increased investment in equipment under the small-farm model would increase the value of the assets listed on the farm balance sheet sevenfold by year five.
- Marketing: The higher product volume of increased production acreage under the small-farm model requires additional market demand and perhaps increased marketing effort.
- Labor: The micro-farm model requires additional labor hours per acre which can be challenging to find.
- Future growth: It is likely easier to expand production using the small-farm model as most of the existing equipment has additional field capacity and additional labor requirements are reduced.
- Mechanical skill set: The increased use of machines in the small-farm model requires an increase in the understanding of and engagement in mechanical work.
- Physical demands: The micro-farm model requires an increase of the physical demands placed on the farm labor. As farmers age, this can become increasingly challenging.

In addition to the above considerations, the observations from the project farmers and OFS students are valuable to consider. In fact, both farmers stated they saw benefits of using both models on their farm and planned on continuing with both models, using each model for different crops, seasons and locations. Comments about the two methods from the farmers and students at the OFS and Oxbow Farm include:

Micro-farm comments:

- The reduced investment costs feel more financially accessible.
- Two-wheel tractors are conducive to early season and late season bed preparation due to their light weight and reduced compaction.

- The narrower 30” bed tops allow for easier harvesting and are more comfortable when reaching to the bed center.
- Two-wheel tractors and some of their implements can be cumbersome and not easy for people of a smaller physical build to maneuver.
- Tasks take more time with a two-wheeled tractor.
- Two-wheel tractors work great for crops with quick successions on small acreage.
- Lack of front-end loader capability is problematic with the two-wheel tractor.
- It is more difficult to incorporate large cover crops without a four-wheel tractor.
- Closer plant spacing can encourage rapid spread if disease is present.
- Two-wheel tractor implements are easier to change.
- Less headlands are required for maneuvering the smaller equipment.

Small-Farm comments:

- Four-wheel tractor tasks require little physical effort.
- Four-wheel tractor farming is more time efficient, and the power of a tractor gives it so many practical uses around the farm.
- Four-wheel tractor implements can be difficult to change.
- Compaction issues are more of a concern with four-wheel tractors.
- Labor costs vastly decrease when using 4W tractor weed cultivation implements.
- Easier to incorporate lots of cover crop biomass.
- Four-wheel tractors are more dangerous with more moving parts and heavy objects that could seriously injure you.
- Four-wheel tractor breakdowns can require more time, knowledge and money to repair and four-wheel tractor systems are more likely to incur higher ‘timeliness costs’ when equipment breakdowns occur.

In addition to these comments, a video about this project was created that contains interviews with project participants about their experiences. It is available for viewing at our website at https://organicfarmschool.org/wsda-grant-outcomes .

Conclusion:

In conclusion, aspiring farmers using this report have many factors to consider when choosing a farming method for a farm start-up. Fortunately, in the experience of this project, the micro-farm model showed viability and potential as an option worthy of consideration for the beginning farmer. While it requires additional labor, the initial investments are smaller, it supports good soil tilth and it feels more accessible to low-resource farmers. A primary drawback, if applicable, would be its limited ability to scale up significantly with most users stating they would prefer a four-wheel tractor if their operations expanded. We recommend that, in addition to developing a business plan, beginning farmers interested in starting a small organic vegetable farm using these models visit and interview farmers, of both micro and small-scale farms, to see and hear first-hand the various pros and cons of each method.

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Appendix: Detailed Activity Costs

Small-Farm Activity Costs: OFS

** Only bed preparation, planting and weed control costs included*

Labor cost/hr: $ 22.14

Activity	Labor hrs/ac	Labor cost/ac	Equip cost/ac	Total cost/ac
Bed preparation				
Mow	1.45	$ 32.11	$ 77.72	$ 109.83
Disc	1.45	$ 32.11	$ 54.75	$ 86.86
Chisel plow	1.45	$ 32.11	$ 111.42	$ 143.53
Spread fertilizer (by hand)	4.35	$ 96.32	$ -	$ 96.32
Spread compost (by hand)	14.50	$ 321.08	$ -	$ 321.08
Shape beds	1.60	$ 35.32	$ 98.89	$ 134.21
Planting			$ -	$ -
Direct-seeding (1 row/pass)	3.19	$ 70.64	$ -	$ 70.64
Transplanting (by hand)	21.75	$ 481.62	$ -	$ 481.62
Weed Control			$ -	$ -
Tractor weeding	2.18	$ 48.16	$ 100.83	$ 149.00
Flame weeding	5.08	$ 112.38	$ -	$ 112.38
Hoeing w/stirrup hoe	21.75	$ 481.62	$ 1.74	$ 483.36
Hand weeding in-row	29.00	$ 642.16	$ -	$ 642.16

Small-Farm Activity Costs: Oxbow

** Only bed preparation, planting and weed control costs included*

Labor cost/hr: $ 22.14

Activity	Labor hrs/ac	Labor cost/ac	Equip cost/ac	Total cost/ac
Bed preparation				
Mow	0.67	$ 14.76	$ 35.73	$ 50.50
Disc	0.67	$ 14.76	$ 25.17	$ 39.94
Chisel plow	0.58	$ 12.92	$ 44.82	$ 57.74
Spread fertilizer	0.75	$ 16.61	$ 25.61	$ 42.22
Power harrow	0.50	$ 11.07	$ 49.81	$ 60.88
Shape beds	0.58	$ 12.92	$ 36.17	$ 49.08
Seed/Transplant:				
Direct-seeding	2.33	$ 51.67	$ 71.66	$ 123.32
Transplanting	40.00	$ 885.74	$ -	$ 885.74
Weed control:				
tractor cultivation	0.83	$ 18.45	$ 38.63	$ 57.09
Hand hoeing	60.00	$ 1,328.61	$ 14.40	$ 1,343.01
Wheel hoeing - w/ finger weede	6.67	$ 147.62	$ 13.80	$ 161.42
Path cultivating	0.50	$ 11.07	$ 30.10	$ 41.17

Appendix: Detailed Activity Costs

Micro-Farm Activity Costs: OFS

** Only bed preparation, planting and weed control costs included*

Labor cost/hr: $ 22.14

Activity	Labor hrs/ac	Labor cost/ac	Equip cost/ac	Total cost/ac
Bed preparation				
Mow	5.4	$ 119.58	$ 142.02	$ 261.60
Rotary plow to raise beds	18.0	$ 398.58	$ 552.96	$ 951.54
Cover w/ silage tarps	4.5	$ 99.65	$ 259.20	$ 358.85
Remove silage tarps	2.7	$ 59.79	$ -	$ 59.79
Broadfork	16.4	$ 362.71	$ 4.75	$ 367.46
Spread compost (by hand)	18.0	$ 398.58	$ -	$ 398.58
Spread fertilizer (by hand)	5.4	$ 119.58	$ -	$ 119.58
Power harrow	5.4	$ 119.58	$ 276.16	$ 395.73
Raking	9.2	$ 203.28	$ 2.30	$ 205.57
Planting				
Direct-seeding (1 row/pass)	9.9	$ 219.22	$ 85.73	$ 304.96
Transplanting (by hand)	54.0	$ 1,195.75	$ -	$ 1,195.75
Weed control				
Flame weeding	6.3	$ 139.50	$ -	$ 139.50
Hoeing w/stirrup hoe	21.6	$ 478.30	$ 1.73	$ 480.03
Hand weeding in-row	39.6	$ 876.88	$ -	$ 876.88

Micro-Farm Activity Costs: Oxbow

** Only bed preparation, planting and weed control costs included*

Labor cost/hr: $ 22.14

Activity	Labor hrs/ac	Labor cost/ac	Equip cost/ac	Total cost/ac
Bed preparation				
Mow crop	8.1	$ 179.36	$ 213.03	$ 392.39
Rotary plow to raise beds	6.3	$ 139.50	$ 193.54	$ 333.04
Cover w/ silage tarps	9.0	$ 199.29	$ 259.20	$ 458.49
Remove silage tarps	5.4	$ 119.58	$ -	$ 119.58
Broadfork	21.6	$ 478.30	$ 6.26	$ 484.56
Spread compost	45.0	$ 996.46	$ 18.45	$ 1,014.91
Spread fertilizer	7.2	$ 159.43	$ -	$ 159.43
Power harrow	3.6	$ 79.72	$ 184.10	$ 263.82
Planting				
Direct-seeding (2 passes)	9.0	$ 199.29	$ 77.94	$ 277.23
Transplanting, hand	45.0	$ 996.46	$ -	$ 996.46
Weed control				
Hoeing	36.0	$ 797.17	$ -	$ 797.17
Hand weeding	54.0	$ 1,195.75	$ -	$ 1,195.75
Landscape fabric install	12.6	$ 279.01	$ 345.51	$ 624.52
Landscape fabric removal	12.6	$ 279.01	$ -	$ 279.01