

Cost of Drip Irrigated Hybrid Carrot Seed Production in the Columbia Basin of Washington

Objectives and Limitations

The goal of this project is to provide estimates of the cost of growing carrot seed (using seed to seed production methods) in the Columbia Basin and to provide industry stakeholders tools for estimating and understanding the costs incurred by carrot seed producers. The estimates developed in this document are intended to capture typical production practices and input use of Columbia Basin carrot seed growers but **cannot capture the exact cost structure and resource use of each individual farm**. Practices outlined in this document are not endorsements or recommendations for any product or practice used in the production of carrot seed. **Farm size, acres planted to carrot seed, equipment choice, rotation, irrigation practices, and management practices will vary and are unique to each individual operation. Agricultural input markets have experienced extreme price volatility. Individuals utilizing this document should exercise caution and consider adjusting pricing to match with the timing of their input purchases and consider adjustments relevant to evolving market conditions.**

Farm Size

The costs and returns estimates in this document are based on a hypothetical 1,000 acre “model” farm. The hypothetical farm considers the cost of growing hybrid carrot seed on 40 acres using drip irrigation. The budget assumes the only drip irrigated crop produced on the farm is carrot seed. Farms that produce multiple drip irrigated crops would benefit from lower overall fixed costs because of the ability to spread some of the costs of equipment associated with installation and removal of drip systems over multiple enterprises.

Rotation Considerations

Choice of rotation crops and length of rotation will vary by producer, field conditions, and the whole farm plan. The crop preceding carrot seed must be chosen wisely since it will require early harvest and will impact weed control and nutrition. Growers must also ensure proper isolation from other carrot and carrot seed production. At a minimum, the whole farm plan must allow for five years between carrot seed crops.

Budget Assumptions and Sensitivity Analysis

The break-even analysis presented in Appendix A uses drip irrigation, is based on 40 acres of carrot seed production, and assumes no germination failure.

We assume one out of every eight years a grower’s seed will fail to meet quality standards resulting in no payment for the crop. The break-even analysis presented in Appendix B includes a “risk adjustment” that increases the total cost per production year to \$5118.53 (based on the assumption the seed germinates seven out of every eight years). When considering the cost of not meeting germination standards, the price required to break even on total costs increases from \$11.20 per pound to \$12.80 per pound, assuming a yield of 400 pounds of seed per acre.

Yield Considerations

Yields will vary based on soil type, variety, location, and weather. The breakeven price per pound represented in both budgets are calculated based on a yield of 400 pounds of seed per acre.

Variable Costs

We estimated two types of costs in the budgets: fixed and variable
Variable costs are:

- 1) Incurred on an annual basis
- 2) Only incurred if the crop is produced
- 3) Vary with the amount of production

The variable cost categories for hybrid carrot seed production include: seed, fertilizer, plant protection, custom and consultants, irrigation, machinery, labor, and operating interest.

Seed

The seed price is budgeted to be \$30.00 per pound and is based on utilizing one pound of seed per acre. Seed costs will vary based on variety.

Fertilizer

Carrot seed variety, yield goals, and price potential can impact the nutrient management decision making process. We estimate nitrogen, phosphorous, and potassium as typical amendments used in the production of carrot seed. Growers may also incorporate sulfur and micronutrients in their soil fertility programs.

Soil tests are required to determine precise nutrient needs for individual producers. Soil testing costs appear in the “custom and consultants” section of the budget, where \$5 per acre is allocated to soil testing. A range of fertilizer practices provided from stakeholder interviews is used to estimate typical fertilization costs. We assume dry fertilizer will be custom broadcast once in August after removal of the wheat crop at a cost of \$10.00 per acre. The per acre application charge is found in the “Custom and Consultants” section of the budget. Surveys with local input dealers provided the pricing used to estimate the fertilizer section of the budget. The budget also includes an allocation for an application of liquid nitrogen. The nitrogen is assumed to be delivered via drip tape. Overall fertilizer requirements are estimated to cost \$512 per acre.

Plant Protection

Weed Control

Methods of weed control vary based on individual preference, environmental factors, economic considerations, and resources of individual producers. In this budget, a combination of chemical applications and mechanical cultivation are assumed for suppression of weeds. Growers and applicators should only use products registered for use in their region and should always read and follow the instructions on the label. A typical herbicide program may include applications of linuron, pendimethalin, fluazifop, quizalofop, clethodim, sethoxydim, or trifluralin (Peachy

2021). Our estimates assume herbicides are used three to four times throughout the production cycle. Per acre herbicide costs are estimated to be \$162.25.

In addition to herbicide applications, the estimates assume carrot seed will be cultivated four times for weed control. Tractor hours and fuel use are estimated using a 160 horsepower wheel tractor to pull the cultivator. Costs of fuel for cultivating are accounted for and discussed in the “Machinery” section of the budget, while the labor hours required for cultivating appear in the labor section of the budget.

Insects

One of the most serious insect pest concerns for carrot seed growers is lygus. Lygus pressure will vary from year to year, field to field, by location, and with environmental factors. Management costs will depend on severity of pressure, and choice of products used. Growers and applicators should only use products registered for use in their region and should always read and follow the instructions on the label. Typical lygus management programs may include use of acephate, azadirachtin, bifenthrin, chlorpyrifos, gamma cyhalothrin, lambda cyhalothrin, naled, or novalouron (Wolheb 2021). Our estimates assume lygus targeted insecticide applications are typically made four to seven times. Beet leafhopper management may be a concern for some growers, requiring consideration of one to two additional applications of insecticides. Growers may also want to consider the cost of one to two applications of insecticides or miticides targeted at twospotted spider mite. Typical products considered for management of twospotted spider mite may include bifenthrin, etoxazole, hexythiazox, or propargite applications (Wohleb 2021). Overall insecticide and miticide allocations are estimated to be \$190.24 per acre, but will ultimately depend on product choice, insect pressure, and the number of applications made.

Diseases & Other Treatments

Fungicide use will vary from season to season and will be dependent on weather conditions. The budgets in this document assume three to five applications of fungicides and fungicide/bactericides may be needed for management of cercospora, alternaria, bacterial blight, and powdery mildew. Growers and applicators should only use products registered for use in their region and should always read and follow the instructions on the label. Individual product choices will vary, but farm operators may consider use of active ingredients such as strobilurin, penthiopyrad, chlorothalonil, copper-based products, mancozeb based products, and fungicide/bactericide products that utilize mancozeb and copper hydroxide (Pscheidt and Ocamb 2021). An allocation of \$150 is made to fungicide and disease treatments in this budget.

Consideration should also be given to proper use of adjuvants when applying any plant protection product. The allowance for the cost of adjuvants is based on a price of \$3.50 per pint of adjuvant and appears in the plant protection category.

Bees

The budget includes a \$500 per acre allocation for bees used to pollinate the seed.

Irrigation

Water Assessment

Water assessments are based on typical fees charged by irrigation districts in the region. A charge of \$90.00 per acre is budgeted for water assessments.

Pumping Charge

The budget assumes the pump used to supply the drip system with water is powered by a diesel engine. Energy requirements for operating the pump are estimated using standard agricultural engineering formulas that relate PSI, pumping lift, and irrigation application rates to the Nebraska Performance Criteria (NPC) water horsepower value for diesel fuel. A minimum of 15 gallons of diesel fuel per acre would be needed to power the pump. Applying the \$3.65 diesel charge to the 15 gallons of fuel results in a total charge of \$54.75 per acre dedicated to fuel for operating the pump. **Since fuel prices fluctuate, users of this document should update the fuel prices to match with current market conditions.**

Irrigation Repair

We allocate \$5.00 per acre for repair and maintenance on the pump.

Drip System Supplies, Setup and Removal

Drip tape and supplies are budgeted at \$325 per acre. Installation and removal of drip irrigation systems is labor intensive. Rolling out the layflat, hooking up couplers, spaghettis, end plugs, and setting up the filter station and pump are all required before the first irrigation can be applied. We budget 8 hours of labor per acre to setting up and removing the drip irrigation system. Once the drip system is removed growers must dispose of the tape. We estimate a \$10 per acre charge to cover drip disposal expenses. The budget includes an allocation to cover the cost of chlorine dioxide needed for maintenance of the drip tape.

Irrigation Labor

The budget assumes utilization of 1.5 hours of labor per acre for managing the drip system after it is installed.

Fuel

All fuel charges that appear in the budget are estimated using pricing from the United States Energy Information Administration. Adjusted wholesale pricing for number 2 diesel is used as a proxy for the dyed (off road) diesel price. Fuel prices often fluctuate, and actual price paid will depend on when fuel is purchased. **Due to extreme volatility users of this document may need to adjust the pricing to capture current market conditions.** The calculated 3 month (Jan 2022-March 2022) historical average price of \$3.65 per gallon is applied to the budget.

On road diesel was estimated using the 3-month (Jan 2022-March 2022) retail average price of \$4.52 per gallon. On road gasoline pricing was based on the 3 month (Jan 2022- March 2022) retail average price of regular gas and is estimated at \$4.14 per gallon.

Variable Costs of Machinery

The operating or variable cost categories that appear under the Machinery heading in the budget include charges allocated to off road diesel for tillage, spraying, planting, and harvest operations.

We allocate a small charge to cover road gas and diesel for pickups and service trucks used on the farm. Machinery repairs, and lube are also accounted for under the machinery heading.

Tillage and Harvest Practices Used to Calculate Fuel Requirements

In preparation for the carrot seed crop that will be planted in August, the wheat stubble from the preceding crop is assumed to be disked twice followed by a custom broadcast fertilizer application. The custom fertilizer application charge is accounted for in the custom and consultants section of the budget, while materials are accounted for in the fertilizer section of the budget. In preparation for planting, the field is plowed, groundhogged twice, landplaned, bedded, and harrowed. Drip tape is assumed to be installed in a separate operation before the carrot seed is planted. However, some operators may increase efficiency by installing the drip tape at the same time the carrot seed is being planted. Other operators using drip systems may wait until spring of the following year to install the drip tape, using other irrigation systems such as sprinkler to supply the fall planting with water. The carrot seed is assumed to be planted with a precision planter. The budget assumes the carrots are thinned once with a mechanical thinner.

Fuel for cultivating is based on the assumption that the carrot seed is cultivated four times. The budgeted fuel for herbicide, insecticide, and fungicide applications will depend on tank mixes, drip tape chemigation, and overall weed, insect, and fungal pressure. Our estimates allocate enough fuel to cover 14 spray applications throughout the growing season.

In preparation for harvest, the drip tape is assumed to be removed with a drip tape lifting tool. The tape is then rolled and prepared for haul away. The cost of drip tape disposal is estimated to be \$10 per acre which appears in the irrigation section of the drip budgets. The layflat must also be removed from the field using a layflat deck.

All budgets assume that in preparation for harvest the male pollinator rows are rolled down. The field is then swathed and combined. A hauling charge is budgeted to capture the cost of delivering seed to the buyer.

Fuel Consumption Calculations

We estimate fuel consumption per hour for all field and harvest operations that are not custom hired by using agricultural engineering equations. Horsepower is related to fuel consumption per hour using a factor of 0.044 for diesel. An example calculation for per hour fuel consumption is provided for a 160 HP tractor ($160 \times 0.044 = 7.04$ gallons per hour of use). Fuel costs per hour are calculated by using the estimated fuel consumption of each operation multiplied by the cost of diesel fuel. Using our previous example ($\$3.65 \times 7.04 = \25.70 per hour).

Acres per hour calculations are used as intermediary step in estimation of final costs used in the budget and apply the following agricultural engineering formula.

$$\frac{\text{Speed (mph)} \times \text{machine width (ft)} \times \text{machines field efficiency (\%)}}{8.25}$$

In this budget all machinery hours are aggregated (tractor + implement) per acre before applying the cost of diesel fuel. An estimated of 33.49 gallons of fuel per acre are calculated and applied to the budget. Applying the \$3.65 per gallon diesel fuel price yields an estimated total cost of \$122.24 per acre for fuel.

Repairs & Maintenance and Lube

Repair and maintenance costs for tractors are based on the purchase price divided by 1,000 multiplied by a factor of 0.083. Repair and maintenance for implements is based on the purchase price divided by 1000 times a factor of 0.05. All individual repair and maintenance charges are aggregated and appropriately allocated to the carrot seed operation to arrive at a single charge per acre for repair and maintenance.

Lubrication costs are estimated using the standard engineering coefficient of 15 percent of estimated fuel costs.

Labor

Assumed wages include a base hourly rate plus adjustments for payroll taxes, workman's compensation and benefits. Base H2-A hourly rates were estimated using Washington's 2022 adverse effect wage rate of \$17.41. per hour (dol.gov 2022).

For locally sourced labor used in the general labor category, an estimated wage of \$18.00 per hour is used. The locally sourced skilled labor rate (equipment operators) is factored at \$19.00 per hour.

We adjust the H-2A labor rate by 25% to cover meals, housing, and transportation, resulting in an effective rate of \$21.76. A 15.25% percent adjustment (to cover payroll taxes and workman's compensation) is applied to the base rate for locally sourced general labor category, resulting in an effective rate of \$20.75 per hour. The labor rate for machinery (tractor and harvest equipment) operators is adjusted by a factor of 25.25% to cover workman's compensation and payroll taxes resulting in an effective wage rate of \$23.80 per hour.

Other Expenses

The budget includes a \$35 per acre charge allocated to crop insurance that appears in the "other" heading of the budget. A \$20 per acre fee is charged for crop consulting fees, which appears in the "custom and consultants" section of the budget.

Roguing Labor

The budgets outlined in this document include an allowance for roging labor. Labor requirements for roging will vary by individual farm. The budgeted 13.5 hours of labor per acre is based on the midpoint of a range of 7 to 20 hours of roging labor per acre.

Operating Interest

Operating Interest is based on a borrowing period of 6 months and is calculated at 5.45% of total operating costs.

Fixed Costs

Fixed costs are incurred even if no production takes place. Fixed costs are:

1. Fixed only after the expense has been incurred
2. A function of time, not output
3. Not relevant for determining optimal level of input use

The **DIRTI** five are the most common category of fixed costs which include **D**epreciation, **I**nterest, **R**ent, **T**axes, and **I**nsurance.

Fixed costs categories for carrot seed production include:

- (1) Depreciation and interest on machinery
- (2) Machinery insurance and housing
- (3) Land Rent

Equipment values are representative of a mix of new and used equipment and are presented on page 8 of this document.

Our calculated ownership costs appear under the fixed cost category of the budget and include annual depreciation, interest, housing and insurance on machinery.

Management & Overhead

Management fees are calculated 5% of operating costs, while overhead is calculated at 2.5% of operating costs.

Land Rent

USDA land rent surveys are used to estimate a cash rental rate of \$390 per acre. The cash land rent does not accurately capture the costs associated with land ownership.

About the Author

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Machinery Complement and Replacement Value Hybrid Carrot Seed Production

**Value based on a mix of new and used equipment

Tractors	Value
Wheel Tractor 75 HP	\$47,094
Wheel Tractor 200 HP	\$157,314
Wheel Tractor 160 HP	\$131,262
Wheel Tractor 250 HP	\$230,460
Tillage	
Landplane	\$15,592
Chisel Plow	\$36,072
Offset Disk	\$25,791
Cultivator	\$12,310
Bedder	\$6,000
Flex Harrow	\$12,000
Combine +Pickup Header	\$350,000
Swather	\$150,000
Groundhog	\$25,498
Service Truck	\$35,467
Pickup	\$40,000
Pickup	\$15,000
4 wheeler	\$7,803
Sprayer Self Propelled	\$88,000
Carrot Thinner (4 row)	\$5,000
Precision Planter	\$10,000
Roller	\$7,000
Tape Installer	\$15,000
Layflat Equip	\$12,024
Tape Puller	\$8,016
Tape Winder	\$13,026

Schedule of Operations Hybrid Carrot Seed Production

Disk 2X	15' Offset Disk +200 HP WT
Broadcast Fertilize	Custom
Plow	20' Chisel Plow +200 HP WT
Groundhog	12' Roller Harrow+160 HP WT
Landplane	16' Landplane +160 HP WT
Bed	Bedder +75 HP WT
Harrow	20' Flex Harrow + 160 HP WT
Plant	20' precision planter + 160 HP WT
Install Drip Tape	4 Row Drip Tape Installer +250 HP WT
Thin Seed	4 Row Thinner +75 HP WT
Spray 14 X	Self Propelled Sprayer
Cultivate 4X	Cultivator + 160 HP WT
Lift Tape	Tape Lifter + 200 HP WT
Roll Tape	Tape Roller +200 HP WT
Roll Layflat	Layflat Deck + 200 HP WT
Swath	15' Swather
Roll Down Males	Roller+ 160 HP WT
Combine	15' pickup header
Haul Seed	Seed Hauling Charge

Works Cited

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- Wohleb, C., 2021. Pests of Carrots Grown for Seed. In: Kaur, N., editor. Pacific Northwest Insect Management Handbook [online]. Corvallis, OR: Oregon State University. <https://pnwhandbooks.org/sites/pnwhandbooks/files/insect/chapterpdf/vegetable-seed.pdf>

Appendix A. Drip Irrigated Hybrid Carrot Seed No Germination Failure 40 acres

	Quantity	Unit	Price	\$/acre
Yield	400	lb	\$11.00	\$4,400.00
Seed				
Seed	1.00	lb	\$30.00	\$30.00
Subtotal Seed				\$30.00
Fertilizer				
NPK	1	ac	\$400.00	\$400.00
Liquid Nitrogen	1	ac	\$112.00	\$112.00
Subtotal Fert				\$512.00
Plant Protection				
Herbicides	1	ac	\$162.25	\$162.25
Insecticides/Miticides	1	ac	\$190.24	\$190.24
Fungicides/Bactericides	1	ac	\$150.00	\$150.00
Adjuvants	14	pt	\$3.50	\$49.00
Chlorine Dioxide (drip lines)	1.0	gal	\$30.00	\$30.00
Subtotal Plant Protection				\$581.49
Custom & Consultants:				
Custom Fertilize	1	ac	\$10.00	\$10.00
Soil Testing	1	ac	\$5.00	\$5.00
Beehive rental	1	ac	\$500.00	\$500.00
Crop Consultant	1	ac	\$20.00	\$20.00
				\$535.00
Irrigation				
Irrigation pump (diesel)	15.00	gal	\$3.65	\$54.75
Irrigation Repair (pump)	1.00	ac	\$5.00	\$5.00
Water Assessment	1.00	ac	\$90.00	\$90.00
Drip Tape/Supplies	1.00	ac	\$325.00	\$325.00
Irrigation Set-up/Removal Labor	8.00	hrs	\$21.76	\$174.08
Drip Tape recycling/haul away	1.00	ac	\$10.00	\$10.00
Total Irrigation				\$658.83
Machinery				
Equipment Fuel	33.49	gal	\$3.65	\$122.25
Road Gas	2.00	gal	\$4.14	\$8.28
Road Diesel	3.00	gal	\$4.52	\$13.56
Repairs	1.00	ac	\$89.07	\$89.07
Lube				\$21.61
Hauling charge	1	ac	\$50.00	\$50.00
Total Fuel, Lube, Repairs				\$304.77
Labor				
Equipment Labor	7.05	hrs	\$23.80	\$167.80
Irrigation Labor	1.50	hrs	\$21.76	\$32.64
General/Hand	5.50	hrs	\$20.75	\$114.13
Roguing	13.50	hrs	\$20.75	\$280.13
Total Labor				\$594.69
Other				
Crop Insurance	1.00	ac	\$35.00	\$35.00
Total Other				\$35.00
Subtotal Variable Costs				\$3,251.78
Interest on Operating Capital				\$88.61
Total Operating Costs				\$3,340.39
Fixed Costs				
Depreciation, Interest, Housing & Insurance On Equipment				\$497.80
Land	1.00		\$390.00	\$390.00
Management				\$167.02
Overhead				\$83.51
Total Fixed Costs				\$1,138.32
Total Operating and Fixed Costs				\$4,478.72
Returns over operating costs				\$1,059.61
Returns over Total Costs				-\$78.72
Operating Cost (per lb)				\$8.35
Total Cost (per lb)				\$11.20
Price		15%	Yield	15%
Breakeven		340	400	460
Operating Cost		\$9.82	\$8.35	\$7.26
Ownership Cost		\$3.35	\$2.85	\$2.47
TC		\$13.17	\$11.20	\$9.74
			Price	
Yield		\$9.35	\$11.00	\$12.65
Operating Cost		357	304	264
Ownership Cost		122	103	90
TC		479	407	354

Appendix B. Drip Irrigated Hybrid Carrot Seed Risk Adjusted for Germination Failure 40 acres

	Quantity	Unit	Price	\$/acre
Seed	Yield 400	lb	\$11.00	\$4,400.00
	Seed 1.00	lb	\$30.00	\$30.00
	Subtotal Seed			\$30.00
Fertilizer				
	NPK 1	ac	\$400.00	\$400.00
	Liquid N 1	ac	\$112.00	\$112.00
	Subtotal Fert			\$512.00
Plant Protection				
	Herbicides 1	ac	\$162.25	\$162.25
	Insecticides/Miticides 1	ac	\$190.24	\$190.24
	Fungicides/Bactericides 1	ac	\$150.00	\$150.00
	Adjuvants 14	pt	\$3.50	\$49.00
	Chlorine Dioxide (drip lines) 1	gal	\$30.00	\$30.00
	Subtotal Plant Protection			\$581.49
Custom & Consultants:				
	Custom Fertilize 1	ac	\$10.00	\$10.00
	Soil Testing 1	ac	\$5.00	\$5.00
	Beehive rental 1	ac	\$500.00	\$500.00
	Crop Consultant 1	ac	\$20.00	\$20.00
				\$535.00
Irrigation				
	Irrigation pump (diesel) 15.00	gal	\$3.65	\$54.75
	Irrigation Repair (pump) 1.00	ac	\$5.00	\$5.00
	Water Assessment 1.00	ac	\$90.00	\$90.00
	Drip Tape/Supplies 1.00	ac	\$325.00	\$325.00
	Irrigation Set-up/Removal Labor 8.00	hrs	\$21.76	\$174.08
	Drip Tape recycling/haul away 1.00	ac	\$10.00	\$10.00
	Total Irrigation			\$658.83
Machinery				
	Equipment Fuel 33.49	gal	\$3.65	\$122.25
	Road Gas 2.00	gal	\$4.14	\$8.28
	Road Diesel 3.00	gal	\$4.52	\$13.56
	Repairs 1.00	ac	\$89.07	\$89.07
	Lube			\$21.61
	Hauling charge 1	ac	\$50.00	\$50.00
	Total Fuel, Lube, Repairs			\$304.77
Labor				
	Equipment Labor 7.05	hrs	\$23.80	\$167.80
	Irrigation Labor 1.50	hrs	\$21.76	\$32.64
	General/hand crews 5.50	hrs	\$20.75	\$114.13
	Covering/ Uncovering Males 6.00	hrs	\$21.76	\$130.56
	Roguing 13.50	hrs	\$20.75	\$280.13
	Total Labor			\$594.69
Other				
	Crop Insurance 1.00	ac	\$35.00	\$35.00
	Total Other			\$35.00
	Subtotal Variable Costs			\$3,251.78
	Interest on Operating Capital			\$88.61
	Total Operating Costs			\$3,340.39
Fixed Costs				
Depreciation, Interest, Housing & Insurance On Equipment				\$497.80
	Land 1.00		\$316.00	\$390.00
	Management			\$167.02
	Overhead			\$83.51
	Total Fixed Costs			\$1,138.32
	Allowance for Germination Failure			\$639.82
	Total Operating, Fixed, and Risk Adjusted Costs			\$5,118.53
	Returns over Total Risk Adjusted Costs			-\$718.53
	Total Risk Adjusted Cost (per lb)			\$12.80
	Price	15%	Yield	15%
	Breakeven	340	400	460
	TC	\$15.05	\$12.80	\$11.13
			Price	
	Yield	\$9.35	\$11.00	\$12.65
	TC	547	465	405