Economic Returns Using Risk-rated Budget Analysis for Rabbiteye Blueberry in Georgia

Esendugue Greg Fonsah[1,5], Gerard Krewer[2], Kerry Harrison[3], and Danny Stanaland[4]

Additional index words. risk-rated returns, production cost, harvesting, marketing, variable costs, fixed costs

Summary. **Rabbiteye blueberry (*Vaccinium ashei*) is the most important type of blueberry grown in Georgia. This species is classified as a highbush blueberry type, but is distinctively different from highbush blueberry (*V. corymbosum*) in its ability to withstand high temperatures and low-organic–matter soils. However, rabbiteye blueberries, like other fruit crops, are subject to price and yield fluctuation. These volatilities depend on several factors, including the cultivar produced and sold, locality, aggregate productivity, targeted market, and timing. As a result, profit margin is hard to determine. The objective of this study was to estimate economic returns using risk-rated budget analysis for rabbiteye blueberry under Georgia conditions. The first-year establishment and maintenance cost of growing rabbiteye blueberry in Georgia was estimated at $5022.04/acre. Total harvesting and marketing cost in the second year was $719.44/acre. In the third year, total variable and fixed cost was $3487.50/acre. In the full production year (fourth year), the cost was estimated at $4671.17/acre. The compounded and recaptured establishment annual cost was $2736.11/acre. The risk-rated expected returns over total costs 63% of the time were $679.00/acre. The chances of making a profit were 77% and the base budgeted net revenue was $369.00/acre. The total budgeted cost was $0.94/lb. The estimated annual total fixed machinery cost was $698.00/acre. The total annual cost of drip irrigation was $161.15/acre.**

Rabbiteye blueberry is the most important blueberry grown in Georgia. An estimated 4.95% of the 6003 acres of blueberries grown in Georgia are rabbiteye blueberry (Florkowski, 2004). This species is classified as a highbush blueberry type, but is distinctively different from highbush blueberry in its ability to withstand high temperatures and lower organic matter soils. Rabbiteye blueberry is relatively high yielding, with commercial yields in the range of 5000 to 8000 lb/acre typical on well-maintained fields. Occasionally, yields in excess of 10,000 lb/acre are reported. Fields may remain productive for 30 years or more.

The fruit is sweet, with excellent firmness and shelf life. Ripening in southern Georgia begins in late May (hand harvest) for some cultivars, but heavy-machine harvest does not begin until the first week of June. Because heavy rains often begin falling in lower-southern Georgia by mid-June, much of the rabbiteye blueberry crop is machine harvested for the processed market in wet years.

Cultural requirements for rabbiteye blueberry are less exacting than highbush blueberry (Krewer and NeSmith, 2002; Smith, 2003; Payne et al. 1993). The bushes grow well in many types of sandy clay loam, loam, loamy sand, and sand soil series if the soil chemistry and soil preparation is correct. Unless a large amount of acidic organic matter is added to the soil, growth usually is much better in virgin soils than in soils previously farmed. Many virgin soils in Georgia have an organic matter content of 2% or more. This represents about 20,000 lb/acre of organic matter. Organic matter should be added to the planting hole or bed on sites with less than 2% organic matter to help get the bushes off to a good start. Normally, milled pine bark or peatmoss is used. Blueberries also respond very well to mulching with acidic materials such as pine bark, pine straw, and pine sawdust. Mulching provides significant weed control and increases the effective root zone as the mulch decomposes. Small grain straws and yard waste also can be used, but have a higher pH.

Land clearing is major expense in blueberry production. Normally, merchantable timber is cut, and stumps are removed, followed by bulldozing with a root rake blade to leave the topsoil behind. Multiple harrowings followed by land leveling to remove small low pockets is required. Large roots are picked up, but small roots and sticks should be left to add organic matter. On wet sites, beds are formed by using a pine tree bedder. The beds are then widened by using a fire break plow or the front gangs of a wood harrow.

Soil pH should be adjusted (if needed) to 4.0 to 5.3 on sandy soils and to 4.5 to 5.3 on clay soils 6 months before planting (Steck and Payne, 1993). Sites that have over 900 lb/acre of calcium and very high levels of phosphorus (300 lb/acre) are less suitable for rabbiteye blueberry. However, if phosphorus levels are very low, phosphorus should be incorporated before planting.

Although rabbiteye blueberry responds well to overhead irrigation

We are indebted to the Southern Small Fruits Consortium for providing funding for this study. We are equally grateful to G. Westberry, W.O. Mizelle, B. Celine, M. Mainland, B. Lisec, T. Cross, and B. Strik for whom their work was used as a starting point for developing this research. We also express our gratitude to Alice H. Pitts who helped with all the formatting, word processing, and tables for this work.

[1]Assistant Professor, Department of Agriculture and Applied Economics, University of Georgia, Tifton, GA 31793

[2]Professor, Department of Horticulture, University of Georgia, Tifton, GA 31793

[3]Biological and Agricultural Engineering Department, University of Georgia, Tifton, GA 31793

[4]County Agent, Clinch County Extension Service, University of Georgia, Homerville, GA 31634

[5]Corresponding author. E-mail: gfonsah@uga.edu.

Units

To convert U.S. to SI, multiply by	U.S unit	SI unit	To convert SI to U.S., multiply by
0.4047	acre(s)	ha	2.4711
0.3048	ft	m	3.2808
3.7854	gal	L	0.2642
9.3540	gal/acre	$L \cdot ha^{-1}$	0.1069
0.7457	horsepower	kW	1.3410
2.54	inch(es)	cm	0.3937
0.4536	lb	kg	2.2046
1.1209	lb/acre	$kg \cdot ha^{-1}$	0.8922
0.7646	yard^3	m^3	1.3080

for freeze protection, typically, drip irrigation is used for rabbiteye blueberry production because of lower cost. Normally, systems are set up to provide a maximum of 2500 to 3000 gal/acre per day during the hottest, driest time of the year. In some areas of southeastern Georgia near the Atlantic coast, there are restrictions on the size of wells allowed (maximum 100,000 gal/d). In this case, a series of 4-inch-diameter wells or filtered surface water may be used instead of a 6- or 8-inch-diameter well.

Growers vary in the type of plants set. Generally 1-gal-size plants are recommended for new growers because weeds can rapidly overgrow smaller plants. However, the use of smaller size plants can offer a significant cost savings in the year of establishment. Many of the newer cultivars have a royalty of $0.25/plant, adding about $150.00/acre to the cost of establishment.

Blueberry is a salt-sensitive plant, but responds well to fertilization. The best results have occurred with a minimum of four fertilizations per year on young plants or one or two applications of slow-release fertilizer per year. Bearing bushes are normally fertilized two or three times per year.

Weed control is a major headache and expense in blueberry production. Much of the rapid growth in a rabbiteye blueberry plant comes from canes that emerge from below ground level or from canes sprouting from renewal pruning cuts. Because these green canes are very sensitive to herbicides, weed control in blueberry is much more difficult than in most fruit crops. Generally, a pre-emergent herbicide is applied in early spring and midsummer. Shielded sprayer or hand-wand applications are needed four to eight times per year, depending on the situation.

Insect and disease control in blueberry can be minimal or extensive, depending on the situation. Many growers are spraying for flea beetle (*Altica sylvia*) and thrips (*Frankliniella vacciaii*) most years. Some growers are spraying for blueberry maggot fly (*Rhagoletis mendax*). Sprays for mummy berry (*Monilinia vacciniicorymbosi)* and botrytis (*Botrytis cinera*) are needed in most commercial fields in most years. Many growers are also applying two to three sprays for leaf spot (*Septoria albopuncata*, *Colletotrichum glocogsocioides*, and *Gloeosporium minus*) each year.

Materials and methods

Rabbiteye blueberry and southern highbush blueberry budgets developed by Westberry et al. (1995), Cline and Mainland (1999), and Lisec et al. (1995) were used as a starting point for developing this budget. Several farm visits and interviews with growers were conducted to study blueberry operations and to collect the necessary primary data needed to estimate cost of production and to obtain information into the type and cost of current practices in southern highbush blueberry culture. Several specialists, extension agricultural economists, horticulturists, agricultural engineers, and county extension agents were visited and interviewed to gather agronomic, irrigation, and equipment data required for this estimate. Vendors of agricultural inputs (fertilizers, chemicals, and equipment) were contacted to obtain the current prices needed to generate variable and the fixed costs components concomitantly. U.S. Department of Agriculture, Economic Research Service publications, and other published resources were consulted to obtain historical information on productivity, marketing, price, and overall outlook of blueberry (Abbe and Messer, 2004; Pollack and Perez, 2003). The objective of this research was to calculate economic returns using risk-rated budget analysis.

Expected returns were computed using a risk-rated method. The risk-rated method assigns five

Table 1. Estimated annual total fixed machinery cost for producing rabbiteye blueberries in Georgia using 7% interest rate in 2005.

Item	Use for this crop (%)	Purchase price ($)[z]	Salvage value ($)	Life (yr)	Depreciation ($)	Interest ($)	Taxes and insurance ($)	Fixed cost ($/acre)[y]
Sprayer, herbicide	100	600	120	5	96	25	5	5.05
Sprayer, air-blast	100	8,000	1,600	5	1,280	336	67	67.33
Rotary mower, 6 ft (1.8 m) diameter	100	1,400	280	7	160	59	12	9.22
Equipment trailer	100	18,000	500	20	875	648	130	66.08
Tractor, 35–45 horsepower (26.1–33.6 kW)	100	25,000	5,000	20	1,000	1,050	210	90.40
Hedger	100	9,000	1,800	10	720	378	76	46.94
Equipment truck	100	20,000	4,000	5	3,200	840	168	168.32
Fertilizer spreader	100	1,500	300	7	171	63	13	9.88
Harvester	100	22,000	4,400	5	3,520	924	185	185.15
Lug carts, four	100	2,600	520	5	416	109	22	21.88
Harrow, 6 ft wide	100	1,200	240	7	137	50	10	7.90
V Blade	100	1,500	300	10	120	63	13	7.82
Golf cart, four, used	100	1,200	240	5	192	50	10	10.10
Hand sprayer	100	150	30	4	30	6	1	1.50
Total investment		112,150	19,330		11,918	4,602	920	698.00
Total fixed costs								17,440.00

[z]These prices were for new equipment except for the four golf carts; used equipment could be purchased at a reduced cost.
[y]Totals may not add up because of a rounding error; $1.00/acre = $2.4711/ha.

categories of yield and price per pound of rabbiteye blueberry, thus the use of "best," "optimistic," "median," "pessimistic," and "worst." Risk-rated returns over total costs was calculated by assigning probabilities or chances of occurrences to each of the categories (Brigham, 1982; Fonsah et al., 2007). The percentage chances of profit and the base budgeted net revenue were then calculated. Furthermore, all variable costs components such as preplant, pre-emergence weed control, planting, transplanter, land-preparation, pest and disease control, and fixed cost components such as machinery, irrigation, recaptured establishment costs, overhead, and management were captured. Variable costs included preharvest, harvesting, and marketing costs. Fixed costs included machinery, irrigation, recaptured establishment costs, overhead, and management. Because of the differences in the cost of land in southern Georgia, we intentionally excluded cost of land in our computation even though this is an opportunity cost accrued by the grower (Fonsah et al., 2007).

ASSUMPTIONS. The risk-rated economic return assumed five different yields and prices per pound at the top of the budget, namely: "best," "optimistic," "median," "pessimistic," and "worst." The "best" and "worst" yield or price levels were expected to occur once in at least 10 years. The "median" yield and price level were expected 63% of the time. The "optimistic" level would be surpassed about 1 year in 6 years, and the "pessimistic" level would occur 1 year in 6 years.

The fourth year was assumed to be in full production. Plant spacing was 5 × 12 ft. Variable interest rates of 7% of total operating/variable costs were used for each year. Cost/flat was based on custom packaging. Hired-used labor was contracted at a flat rate of $10.00/h. The brokerage fee was 15%, but it included cooling and handling. The overhead and management fee was 15% of the total operating/variable cost. Compounded recaptured costs were based on a 7% fixed interest rate and the expected life-span of the farm under Georgia conditions was 20 years. Machinery and equipment operation costs calculations were estimated on 50 acres because growers with a smaller farm size would not invest in this type of equipment and machinery. The fixed interest rate used was 7%.

All of the computations included such items as percentage use for crop, purchase price, salvage value, life

Table 2. Recapture establishment cost per acre of producing rabbiteye blueberries in Georgia compounded for 20 years at 7% interest rate.

Time to production (yr)	Compounded interest rate (%)	Pre-establishment costs ($)	Total ($)[z]
4	1.31	5,022.04	6,582.88
3	1.23	1,498.18	1,835.34
2	1.14	1,621.35	1,856.28
1	1.07	283.66	303.52
Compounded establishment cost			10,578.02
Recaptured annual establishment cost ($/acre)[y]			2,736.11

[z]Totals may not add up because of a rounding error.
[y]$1.00/acre = $2.4711/ha.

Table 3. Estimated cost per acre of drip irrigation for producing rabbiteye blueberries in Georgia based on 25 acres (10.1 ha) with 12-ft (3.7 m) spacing and a 20-horsepower (14.9 kW) electric motor in 2005.

Investment and annual fixed costs	New cost ($/acre)[z]	Life (yr)	Annual depreciation ($/acre)	Annual interest ($/acre)	Annual taxes and insurance ($/acre)[y]
Pipe and fittings	6,250	20	313	219	47.00
Drip tape	5,000	7	714	175	38.00
Well, 6 inches (15.2 cm) diameter	11,000	25	440	385	83.00
Pump and motor	6,000	15	400	210	45.00
Irrigation filter and automatic controller	2,000	10	200	70	15.00
Water meter	1,500	10	150	53	11.00
Installation	5,000	20	250	175	38.00
Total investment	36,750		2,467	1,287	277.00
Total annual fixed costs ($)					4,029.00
Annual fixed costs ($/acre)					161.15
Operating costs					
Pump size (horsepower)[x]			20		
Repairs ($)			776		
Annual pumping time (h)			200		
Electricity					
Annual demand (standby charge) ($)			240		
Rate ($/kW-h)			0.08		
Energy costs ($/yr)			479		
Annual energy costs ($/acre)					19.15
Annual operating cost ($/acre)					50.20
Total annual costs ($/acre)					211.35

[z]$1.00/acre = $2.4711/ha.
[y]Totals may not add up because of rounding errors.
[x]1 horsepower = 0.7457 kW.

span, depreciation, interest, tax, and insurance. All equipment was assumed to be new. Drip irrigation was calculated based on 25 acres because that was the average farm size for new entrants. The drip line spacing was 12 × 45 ft, and had a 6-inch-diameter well capable of pumping about 300 gal/min. Risk-rated marketing prices and yields were obtained from growers and from Michigan Blueberry Growers Marketing (Grand Junction, MI). Input and equipment prices were obtained from vendor and machinery dealers, respectively. The adopted variable interest rates for operating/variable costs were for short-term loans. The fixed interest rates used for fixed, machinery, and compounded establishment costs were for long-term loans.

Farm input prices. There were several factors that could influence the price of inputs, the total cost of production, and profit margin. Many farmers in Georgia need not invest in drip irrigation materials or dig a new well because they already had them available. If so, that would significantly increase profitability. Also, motor sizes of the drip irrigation were different depending on acreage.

Table 4. Estimated first-year establishment and maintenance cost of producing rabbiteye blueberries in Georgia in 2005.

Items	Applications (no./yr)	Unit of application[z]	Quantity of application (units/yr)	Price per application ($/unit per yr)	Total cost ($/acre per yr)[y]
Land preparation[x]					
Preplant weed control		gal	2.50	36.00	90.00
Stumping, pushing, burning[w]		acre	1.00	500.00	500.00
Chopping		acre	3.00	40.00	120.00
Triple super phosphate (0N–19.6–0K)		lb	150.00		0.00
Harrowing		acre	3.00	30.00	90.00
Bedding		acre	1.00	45.00	45.00
Breaking aisles		acre	1.00	30.00	30.00
Ditching and drainage		acre	1.00	80.00	80.00
Milled pine bark[v]		yard^3	90.00	7.00	630.00
Planting					
Plants, 4 × 12-ft (1.2 × 3.7 m) spacing		acre	840.00	1.35	1,134.00
Planting labor (five people)	5	acre	15.00	10.00	150.00
Transplanter rental		acre	1.00	11.25	11.25
Fertilizers					
Fertilizer (10N–4.4P–8.3K)	6	lb	600.00	0.12	72.00
Labor (hand/mechanical)	6	h	6.00	8.33	49.98
Weed control					
Pre-emergence	2	acre	2.00	35.00	70.00
Postemergence	2	acre	2.00	20.00	40.00
Tractor and sprayer	4	h	4.00	9.00	36.00
Labor	4	h	4.00	10.00	40.00
Pest and disease control[u]					
Insecticide	2	acre	2.00	10.00	20.00
Fungicide	1	acre	1.00	20.00	20.00
Tractor and sprayer	3	h	3.00	9.00	27.00
Labor	3	acre	3.00	10.00	30.00
Pruning	1	h	3.00	7.00	21.00
Mowing	3	h	3.00	9.00	27.00
Irrigation[t]		acre	1.00	50.20	50.20
Interest on operating costs		$	3,383.43	0.07	236.84
Total operating costs					3,620.27
Fixed costs					
Tractor and equipment		acre	1.00	697.59	697.59
Overhead and management		$	3,620.27	0.15	543.04
Irrigation		acre	1.00	161.15	161.15
Land[s]		$	1.00	0.00	0.00
Total fixed costs					1,401.78
Total establishment costs					5,022.04

[z]1 gal = 3.7854 L, 1 acre = 0.4047 ha, 1 lb = 0.4536 kg, 1 yard^3 = 0.7645 m^3.
[y]Totals may not add up because of rounding errors; $1.00/acre = $2.4711/ha.
[x]Customized service.
[w]Range from $300 to $1200, depending on the number and size of stumps. Stumps are the basal part of trees with roots remaining after the trunk has been cut.
[v]Soils with less than 2% organic matter might need pine bark to stimulate growth.
[u]Mummyberry (*Monilinia vacciniicorymbosi*), phytophthora root rot (*Phytophthora cinnamoni*), leaf spot (*Septoria albopuncata*, *Colletotrichum glocogsocioides*, and *Gloeosporium minus*), and fruit rot (*Alternaria tenuissima*, *Colletotrichum gloeosporioides*, and *Botrytis cinerea*).
[t]This cost is for drip irrigation. The cost of solid set is estimated at $189.15/acre.
[s]A typical price per acre varies significantly. The annual leasing price often ranges from $60/acre to $100/acre.

Table 5. Estimated second-year annual establishment and maintenance cost per acre of producing rabbiteye blueberries in Georgia in 2005.

Items	Applications (no./yr)	Unit of application[z]	Quantity of application (units/yr)	Price per application ($/unit per yr)	Total cost ($/acre per yr)[y]
Operating costs					
Fertilizers					
Fertilizers (10N–4.4P–8.3K)	6	h	600.00	0.12	72.00
Labor (hand/mechanical)	6	h	6.00	8.33	49.98
Weed control					
Pre-emergence	2	acre	2.00	35.00	70.00
Postemergence	2	acre	2.00	20.00	40.00
Tractor and sprayer	4	h	4.00	9.00	36.00
Labor	4	h	4.00	10.00	40.00
Pest and disease control[x]					
Insecticide	2	acre	2.00	10.00	20.00
Fungicide	1	acre	1.00	20.00	20.00
Tractor and sprayer	3	h	3.00	9.00	27.00
Labor	3	acre	3.00	10.00	30.00
Pruning	1	h	6.00	7.00	42.00
Mowing	3	h	3.00	9.00	27.00
Irrigation[w]		acre	1.00	50.20	50.20
Interest on operating costs		$	524.18	0.07	36.69
Total operating costs					560.87
Harvesting and marketing costs					
Harvesting (manual)		lb	500.00	0.65	325.00
Custom packing			55.56	5.00	277.78
Cooling, handling, and brokerage		$	55.56	14.00	116.67
Total harvesting and marketing costs					719.44
Total establishment costs					2,223.18
Less return from receipts		$	500.00	1.45	725.00
Total costs					1,498.18
Fixed costs					
Tractor and equipment		acre	1.00	697.59	697.59
Overhead and management		$	560.87	0.15	84.13
Irrigation		acre	1.00	161.15	161.15
Land[v]		$	1.00	0.00	0.00
Total fixed costs					942.87

[z]1 acre = 0.4047 ha, 1 lb = 0.4536 kg.
[y]Total may not add up because of rounding errors; $1.00/acre = $2.4711/ha.
[x]Mummyberry (*Monilinia vacciniicorymbosi*), phytophthora root rot (*Phytophthora cinnamoni*), leaf spot (*Septoria albopuncata*, *Colletotrichum glocogsocioides*, and *Gloeosporium minus*), and fruit rot (*Alternaria tenuissima*, *Colletotrichum gloeosporioides*, and *Botrytis cinerea*).
[w]This cost is for drip irrigation. The cost of solid set is estimated at $189.15/acre.
[v]A typical price per acre varies significantly. The annual leasing price often ranges from $60/acre to $100/acre.

Quantity discounts for items such as packing supplies were factors that affected price of inputs. The cost estimate in this budget reflects a combination of the current cultural practices in Georgia. The prices were actual prices from vendors around the counties involved in blueberry production, and they excluded quantity discounts.

Estimated annual total fixed machinery costs. Fixed machinery cost included sprayers, rotary mower, wagons, tractor, hedger, truck, spreader, mulcher, harrow, and V blade (Table 1). These costs included the percentage of use for rabbiteye blueberry, the purchase price, salvage value, life span of equipment, depreciation, interest, tax, and insurance. The calculation was based on 25 acres and a 7% fixed interest rate. Based on this study, the estimated fixed machinery cost was $698.00/acre.

Compounded and recaptured establishment costs. The total establishment costs for years 1, 2, 3, and 4 were $5022.04/acre, $1498.18/acre, $1621.35/acre, and $283.66/acre, respectively. These costs were compounded using the University of Georgia Engineering and Economic calculations (Brown and Skinner, 1980). The fixed compounded interest rate was 7%. In our calculation, we used 20 years because we believe that to be the life-span of a well-managed rabbiteye blueberry farm in Georgia. The annual recapture establishment cost was $2736.11/acre (Table 2).

Drip irrigation cost. The annual fixed cost of irrigation was estimated at $161.15/acre and included pipes and fittings, sprinklers, a 6-inch-diameter well that can handle a 300-gal/min pump, motor, installation, and miscellaneous. The variable/operating cost component of the drip irrigation was $50.20/acre. This calculation was based on

25 acres, and drip tapes were 12 × 12-inch spacing and a 20-horsepower motor. The cost would have been extremely high if only 1 acre was used. For instance, the total annual fixed cost per 25 acres was $4031.00, whereas the total annual fixed cost was $211.35/acre (Table 3).

Results and discussion

The following sections provide a detailed discussion of the estimated establishment and maintenance costs to be incurred in each production year. In this analysis, full production is assumed to be attained on the fourth year of operations.

Estimated establishment and maintenance: Year 1. The total operating/variable cost of growing rabbiteye blueberry in Georgia was estimated at $3620.27/acre. The total fixed cost was estimated at $1401.78/acre. Therefore, the total estimated establishment and maintenance cost for the first year was $5022.04/acre (Table 4). The planting distance was 4 × 10 ft, equivalent to 840 plants/acre costing $1134.00/acre. Other expensive cost components in land preparation operation were stumping (the remains of a cut-down tree that contains the roots), pushing stumps and large limbs, and burning, which costs $500.00/acre depending on the number of stumps, chopping, which costs $120.00, and milled pine bark, which costs $630.00 for 90 yard^3. Fertility and pre- and postemergence weed control cost were $307.98/acre (Table 4).

Estimated establishment and maintenance: Year 2. In year two, the cost of weed control was

Table 6. Estimated third-year establishment and maintenance cost per acre of producing rabbiteye blueberries in Georgia in 2005.

Item	Applications (no./yr)	Unit of application[z]	Quantity of application (units/yr)	Price per application ($/unit per yr)	Total cost ($/acre per yr)[y]
Operating costs					
Fertilizers					
Fertilizer (10N–4.4P–8.3K banded)	6	lb	600.00	0.12	72.00
Labor (hand/mechanical)	6	h	6.00	8.33	49.98
Weed control					
Pre-emergence	2	acre	2.00	35.00	70.00
Postemergence	2	acre	2.00	20.00	40.00
Tractor and sprayer	4	h	4.00	9.00	36.00
Labor	4	h	4.00	10.00	40.00
Pest and disease control[x]					
Insecticide	2	acre	2.00	10.00	20.00
Fungicide	3	acre	3.00	20.00	60.00
Tractor and sprayer	5	h	5.00	9.00	45.00
Labor	5	acre	5.00	10.00	50.00
Pruning	1	h	3.00	7.00	21.00
Mowing	3	h	3.00	9.00	27.00
Pollination	1	acre	1.00	35.00	35.00
Irrigation[w]		acre	1.00	50.20	50.20
Interest on operating costs		$	616.18	0.07	43.13
Total operating costs[v]					659.31
Harvesting and marketing costs					
Harvesting (hand picking)		lb	1,300.00	0.65	845.00
Custom packing		flat	144.44	5.00	722.22
Cooling, handling, and brokerage: fresh		$	144.44	14.00	303.33
Total harvesting and marketing costs					1,870.56
Fixed costs					
Tractor and equipment		acre	1.00	697.59	697.59
Overhead and management		$	659.31	0.15	98.90
Irrigation		acre	1.00	161.15	161.15
Land[u]		$	1.00	0.00	0.00
Total fixed costs					957.63
Gross establishment costs					3,487.50
Less return from receipts		$	1,287.00	1.45	1,866.15
Total net establishment costs					1,621.35

[z]1 lb = 0.4536 kg, 1 acre = 0.4047 ha, 1 flat = 1.5 kg (3.31 lb).
[y]Totals may not add up because of rounding errors; $1.00/acre = $2.4711/ha.
[x] Mummyberry (*Monilinia vacciniicorymbosi*), phytophthora root rot (*Phytophthora cinnamoni*), leaf spot (*Septoria albopuncata*, *Colletotrichum glocogsocioides*, and *Gloeosporium minus*), and fruit rot (*Alternaria tenuissima*, *Colletotrichum gloeosporioides*, and *Botrytis cinerea*).
[w]This cost is for drip irrigation. The cost of solid set is estimated at $189.15/acre.
[v]Although year 3 budget is calculated on 100% fresh, there is a possibility to pick some fruit for frozen. Custom machine pick costs about $0.13/lb ($0.287/kg).
[u]A typical price per acre varies significantly. The annual easing price often ranges from $60/acre to $100/acre.

$186.00/acre, at 33% of total variable cost. The total variable cost was $560.87/acre, which is 6.5 times lower than year one. It was assumed that 500 lb of blueberries would be harvested in year two.

Total harvesting and marketing costs were $719.44/acre. This includes harvesting, custom packing, cooling, handling, and brokerage fees. Fixed costs include tractor and equipment, overhead and management,

Table 7. Estimated fourth-year establishment and maintenance cost per acre of producing rabbiteye blueberries in Georgia in 2005.

Item	Applications (no./yr)	Unit of application[z]	Quantity of application (units/yr)	Price per application ($/unit per yr)	Total cost ($/acre per yr)[y]
Operating costs					
Fertilizers					
Fertilizer (10N–4.4P–8.3K, banded)	3	lb	612.00	0.12	73.44
Tractor and spreader	3	h	3.00	9.00	27.00
Labor	3	h	3.00	10.00	30.00
Weed control					
Pre-emergence	2	acre	2.00	35.00	70.00
Postemergence	2	acre	2.00	20.00	40.00
Tractor and sprayer	4	h	4.00	9.00	36.00
Labor	4	h	4.00	10.00	40.00
Pest and disease control[x]					
Insecticide (preharvest)	2	acre	2.00	10.00	20.00
Insecticide (postharvest)	2	acre	2.00	10.00	20.00
Fungicide (preharvest)	4	acre	4.00	37.50	150.00
Fungicide (postharvest)	2	acre	2.00	12.50	25.00
Tractor and sprayer	10	h	10.00	9.00	90.00
Labor	10	h	10.00	10.00	100.00
Pollination					
Bee hives	1	acre	2.00	35.00	70.00
Gibberellic acid	2	oz	40.00	1.00	40.00
Tractor and sprayer	2	h	2.00	9.00	18.00
Pruning[w]					
Pruning	1	bush	840.00	0.25	210.00
Mowing	3	h	3.00	9.00	27.00
Labor	3	h	3.00	10.00	30.00
Irrigation[v]		acre	1.00	50.20	50.20
Interest on operating costs		$	1,166.64	0.07	81.66
Total operating costs					1,248.30
Harvesting and marketing costs					
Custom harvesting		lb	4,500.00	0.13	585.00
Custom packing: fresh		flat	250.00	5.00	1,250.00
Cooling, handling, and brokerage: fresh		flat	250.00	13.10	491.25
Frozen packing		lb	2,250.00	0.15	50.63
Total harvesting and marketing costs					2,376.88
Fixed costs					
Tractor and equipment		acre	1.00	697.59	697.59
Overhead and management		$	1,248.30	0.15	187.25
Irrigation		acre	1.00	161.15	161.15
Land[u]		$	1.00	0.00	0.00
Total fixed costs					1,045.98
Total establishment costs					4,671.16
Less return from receipts: fresh			2,250.00	1.45	3,262.50
Less return from receipts: frozen			2,250.00	0.50	1,125.00
Net return from receipts: fresh and frozen					4,387.50
Total cost					283.65

[z]1 lb = 0.4536 kg, 1 acre = 0.4047 ha, 1 oz = 28.3495 g, 1 flat = 1.5 kg (3.31 lb), 1 fl oz = 29.5735 mL.
[y]Totals may not add up because of rounding errors; $1.00/acre = $2.4711/ha.
[x] Mummyberry (*Monilinia vacciniicorymbosi*), phytophthora root rot (*Phytophthora cinnamoni*), leaf spot (*Septoria albopuncata*, *Colletotrichum glocogsocioides*, and *Gloeosporium minus*), and fruit rot (*Alternaria tenuissima*, *Colletotrichum gloeosporioides*, and *Botrytis cinerea*).
[w]Mechanical or manual depending on the field.
[v]This cost is for drip irrigation. The cost of solid set is estimated at $189.15/acre.
[u]A typical price per acre varies significantly. The annual leasing price often ranges from $60/acre to $100/acre.

and irrigation, which altogether cost $942.87/acre. The total cost for year two was $2223.18/acre. Assuming a return from receipts of 500 lb and a selling price of $1.45/lb, gross receipts were $725.00. This reduced the total establishment cost in year two to $1498.18/acre (Table 5).

Estimated establishment and maintenance: Year 3. In year three, the total variable cost was $659.31/acre. With an estimated quantity of 1300 lb of blueberries, the total harvesting and marketing costs were $1870.56/acre. This included harvesting, custom packing, cooling, handling, and brokerage fees. Fixed costs included tractor and equipment, overhead and management, and irrigation, which altogether cost $957.63/acre. The total cost for year three was $3489.57/acre. Assuming a return from receipts of 1300 lb and a selling price of $1.45/lb, gross receipts were $1866.15/acre. This, minus the actual total cost of $3489.57/acre, equals a net establishment cost of $1621.35/acre in year three (Table 6).

Full production cost: Year 4. In the fourth year, the rabbiteye blueberry field is assumed to be in full production. The combined mowing and pruning operations was the largest variable cost component, at $267.00/acre or 21% of total variable cost. A combined pollination operation cost was $128.00/acre or 10% of total variable cost. Total harvesting and marketing costs were $2376.88/acre. This included harvesting, custom packing (fresh and frozen), cooling, handling, and brokerage fees. Fixed costs include tractor and equipment, overhead and management, and irrigation, which altogether cost $1045.99. The total cost/acre during this first full production year was $4671.17/acre. Assuming a return from receipts of 5000 lb with 50% sold fresh at $1.45/lb and the other 50% sold frozen at $0.50/lb, gross receipts of $4875.00/acre would be generated. This, minus the actual total cost of $4671.17/acre, equals a net establishment cost of $283.67/acre in year four (Table 7).

Economic risk-rated expected returns. If the expected return or yield for rabbiteye blueberry in Georgia was 5000 lb/acre and the expected price is $1.45/lb, then the total return will be $7250.00/acre if sold fresh. However, if only 50% was sold fresh and the remainder was sold as frozen at the price of $0.05/lb, then the total expected return will be $4875.00/acre.

Economic risk-rated returns over total costs. Table 8 shows the probabilistic chances of obtaining the various calculated risk-rated net return over total costs. The "returns" row of Table 8 depicts six different net return possibilities. According to Westberry et al. (1995), "all net returns are determined from their relationship to the expected net return. They are not determined by multiplying prices and yields then subtracting the total cost. Rather, they reflect the variability of prices and yields. The first 'chances' row shows the estimated frequency of obtaining the above net returns or more. The second 'chances' row shows the estimated frequency of obtaining the above net returns or less."

For instance, there was only an 8% chance of obtaining $7772.00/acre of rabbiteye blueberry in Georgia, whereas there was a 5% chance of earning a negative return of –$1698.00/acre. Furthermore, there was a 63% chance of earning the expected $679.00/acre. The economic risk-rated return over total costs further depicted that the base budgeted net revenue was $369.00/acre with a 77% chance of making a profit under Georgia conditions if sold fresh (Table 8).

Sensitivity analysis and economic risk-rated returns over total costs. An economic risk-rated sensitivity analysis over total costs of producing and selling rabbiteye blueberry was conducted to determine the riskiness and profitability margin under five different price and yield levels, respectively. Two price levels, selling 100% fresh or selling 50% fresh and 50% processed were analyzed to determined which combination provide optimum financial benefit to the rabbiteye blueberry growers (Table 9). The pessimistic yields used for this analysis were 3,000 and 4,000 lb/acre, and the optimistic yields were 8,000 and 12,000 lb/acre. The five different sensitivity prices used for selling rabbiteye blueberries 100% fresh were $1.10/lb, $1.25/lb, $1.45/lb, $1.85/lb, and $2.10/lb. The combined rabbiteye blueberry average prices for selling 50% fresh and 50% processed were $0.68/lb, $0.80/lb, $0.98/lb, $1.25/lb, and $1.43/lb, respectively. Table 9 shows that if a pessimistic yield of 4000 lb/acre were produced and sold all fresh at $1.85/lb, the grower will obtain a positive return of $247.00/acre, whereas he/she would obtain a negative return of –$765.00/acre if the crop was sold at an average combined 50% fresh and 50% processed price of $1.25/lb. With an optimistic yield of 8000 lb/acre, a positive return of $4538.00/acre would be achieved if sold all fresh at a reduced price of $1.10/lb or a return of $2421.00/acre if sold at an average combined price of $0.68/lb for 50% fresh and 50% processed.

Conclusion

The total establishment costs for years 1, 2, 3, and 4 were $5022.04/acre, $2223.18/acre, $3487.50/acre, and $1045.98/acre, respectively. The annual recapture establishment cost was $2736.11/acre. The estimated fixed machinery cost was $698.00/acre. The annual fixed cost of irrigation/acre was estimated at $161.15/acre and included pipes and fittings, sprinklers, a 6-inch-diameter well that can handle a 300-gal/min pump, motor, installation, and miscellaneous.

The preharvest variable cost was $0.25/lb. The harvesting and marketing cost was estimated at $0.23/lb,

Table 8. Economic risk-rated returns over total costs of producing rabbiteye blueberries in Georgia in 2005.

	Optimistic		Expected		Pessimistic	
Returns ($)[z]	7,772	5,937	679	944	–377	–1,698
Chances (%)[y]	8	16	63	58	84	1
Chances (%)[x]	92	84	37	42	16	5
Chances for profit = 77%			Base budgeted net revenue = $369			

[z]Net return levels.
[y]The chances of obtaining this level or more.
[x]The chances of obtaining this level or less.

Table 9. Sensitivity analysis and economic risk-rated returns for price and yield over total costs of producing and selling fresh and frozen rabbiteye blueberries in Georgia in 2005.

Price fresh and frozen ($/lb)[z]	Pessimistic yield of 3000 lb/acre ($/acre)[y]	Pessimistic yield of 4000 lb/acre ($/acre)	Expected yield of 5000 lb/acre ($/acre)	Optimistic yield of 8000 lb/acre ($/acre)	Optimistic yield of 12,000 lb/acre ($/acre)	Base budgeted net revenue ($)[x]	Chances for profit (%)[w]
1.10[v]	–2,184	–1,105	–56	4,538	6,280	–1,381	50
0.68[u]	–3,280	–2,489	–938	2,421	4,084	–3,481	23
1.25[v]	–1,946	–765	259	5,154	6,932	–631	64
0.80[u]	–2,871	–1,995	–686	3,126	4,811	–2,881	30
1.45[v]	–1,698	–377	679	5,937	7,772	369	77
0.98[u]	–2,417	–1,419	–308	4,013	5,730	–1,981	43
1.85[v]	–1,369	247	1,519	7,466	9,461	2,369	86
1.25[u]	–1,946	–765	259	5,154	6,932	–631	64
2.10[v]	–1,245	565	2,044	8,432	10,555	3,619	88
1.43[u]	–1,720	–413	637	5,860	7,689	269	76

[z]$1.00/lb = $2.2046/kg.
[y]1 lb/acre = 1.1209 kg·ha^{-1}, $1.00/acre = $2.4711/ha.
[x]The percentage chance for profit was calculated based on the expected yield of 5000 lb/acre and the given price.
[w]The base budgeted net revenue was calculated based on the expected yield of 5000 lb/acre and the going price.
[v]This row is the price per pound for rabbiteye blueberries sold 100% fresh.
[u]This row is the average price per pound for rabbiteye blueberries sold 50% fresh and 50% processed.

and the fixed cost was $0.47/lb. The total budgeted cost amounted to $0.95/lb. Total operating costs were $5024.12/acre, $1500.26/acre, $1623.42/acre, and $63.91/acre for years 1, 2, 3, and 4, respectively. Harvesting and marketing costs were $719.44/acre, $1870.55/acre, and $2642.55/acre for years 2, 3, and 4, respectively. Total fixed costs were $1403.85/acre, $944.94/acre, $959.71/acre, and $1048.06/acre for years 1, 2, 3, and 4, respectively.

In year 4, combined pruning operation was the largest variable cost component, at $267.00/acre, equivalent to 21% of the total variable/operating cost. Pollination operation contributed to over 10% of total variable cost, equivalent to $128.00/acre. Total harvesting and marketing costs were $2376.88/acre. Fixed machinery cost was $698.00/acre and included sprayers, rotary mower, wagons, tractor, hedger, truck, spreader, mulcher, harrow, and V blade.

The annual fixed cost of drip irrigation was estimated at $161.15/acre and included pipes and fittings, tube, a 6-inch-diameter well capable of pumping 300 gal/min, pump, motor, installation and miscellaneous. The variable/operating cost component of the drip irrigation was $50.20/acre, and the total annual costs (i.e., total operating cost plus total annual fixed costs) were $211.35/acre.

The expected yield for rabbiteye blueberry in Georgia was 5,000 lb/acre. The risk-rated net returns showed that there was only an 8% chance of obtaining $7772.00/acre of rabbiteye blueberry in Georgia, whereas there was a 16% chance of earning a negative return of –$377.00/acre. Furthermore, there was a 63% chance of earning the expected $679.00/acre. The risk-rated returns over total costs further depicted that the base budgeted net revenue was $369.00/acre with a 77% chance of making a profit under Georgia conditions.

An economic risk-rated sensitivity analysis over the total costs of producing and selling rabbiteye blueberry was conducted to determine the riskiness and profitability margin under five different price and yield levels. The results showed that if a pessimistic yield of 4000 lb/acre were produced and sold all fresh at $1.85/lb, then growers will obtain a positive return of $247.00/acre, whereas he/she would obtain a negative return of –$765.00/acre if the crop was sold at an average combined 50% fresh and 50% processed price of $1.25/lb. With an optimistic yield of 8000 lb/acre, a positive return of $4538.00/acre would be achieved if sold all fresh. A reduced price of $1.10/lb or a return of $2421.00/acre would be achieved if sold at an averaged combined price of $0.68/lb for 50% fresh and 50% processed.

Literature cited

Abbe, D.S. and C.S. Messer. 2004. Agricultural prices. Official Georgia estimate: Blueberries. Census of agriculture Georgia profiles. 4 Nov. 2004. <http://www.nass.usda.gov/ga/cropests/bluebery.txt>.

Brigham, E.F. 1982. Financial management theory and practice. 3rd ed. Dryden Press, New York.

Brown, E. and R.E. Skinner. 1980. Economic analysis of selected sprinkler irrigation systems. Univ. Georgia Coop. Ext. Serv. Bul. 731.

Cline, B. and M. Mainland. 1999. Blueberry production recommendations and costs introduction. Proc. 33rd Annual Open House North Carolina Blueberry Council, Elizabethtown, NC. p. 9–12.

Florkowski, W.J. 2004. Commercial blueberry inventory and prospectus. Univ. Georgia 2002 Res. Rpt. No. 693.

Fonsah, E.G., G. Krewer, K. Harrison, and M. Bruorton. 2007. Risk-rated economic return analysis for southern high bush blueberries in soil in Georgia. HortTechnology 17:571–579.

Krewer, G. and D.S. NeSmith. 2002. The Georgia blueberry industry: Its history, present state and potential for development in the next decade. Acta Hort. 574:101–106.

Lisec, B., T. Cross, and B. Strik. 1995. Blueberry economics: The costs of establishing and producing blueberries in the Willamette Valley, Oregon State Univ. Ext. Serv. EM 8526.

Payne, J.A., A.A. Amis, R.J. Beshear, R.J. Gagne, D.L. Horton, and P.M. Lyrene. 1993. "New" rabbiteye blueberry insects: Maggots, midges, thrips, and root weevils, p. 37–38. In: G. Krewer (ed.). Proc. 6th Biennial Southeast Blueberry Conf., Tifton, GA.

Pollack, S. and S. Perez. 2003. Fruit and tree nuts situation and outlook yearbook. Market Trade Economic Div., Economic Res. Serv., U.S. Dept. Agr., October, FTS-2003.

Smith, B.J. 2003. Susceptibility of southern highbush blueberry cultivars to phytophthora root rot and botryosphaeria stem bight, p. 18–27. In: G. Krewer (ed.). Proc. Georgia-outh Carolina Blueberry Conf., Savannah, GA.

Steck, G.J. and J.A. Payne. 1993. Blueberry maggot, *Rhagoletis mendax* (Diptera: Tephritidae). Florida Dept. Agr. Consumer Serv., Div. Plant Ind., Entomol. Circ. No. 358.

Westberry, G.O., W.O. Mizelle, D. Stanaland, and G. Krewer. 1995. Economic analysis of producing commercial blueberries. Univ. Georgia. Ag-Econ. Bul. 95–040.