

A Comparison of Three Non-Migratory Systems for Managing Honey Bees (*Apis mellifera* L.) in Minnesota

Part II: Economic Analysis^{1,2,3}

by S. R. DUFF and B. FURGALA

Department of Entomology, University of Minnesota, St. Paul, Minnesota 55108

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ABSTRACT

Enterprise budgets were prepared for three 2-queen management systems (package colonies, vertical 2-queen, and horizontal 2-queen). Economic comparisons were based on production data and estimated costs for a 500 2-queen unit operation. The horizontal 2-queen management system yielded the most surplus honey and generated the highest gross receipts. The package colony system had the highest operating costs, the vertical 2-queen system the lowest. The net returns above costs shown differed significantly among treatments, with the horizontal 2-queen system showing the greatest return.

INTRODUCTION

SEVERAL COMPARISONS of honey bee management methods have been reported, but few have included an economic analysis. In Manitoba, Braun (1941) found that overwintered colonies were more profitable than package colonies and that divided overwintered colonies increased beekeepers' income. In an economic comparison under commercial conditions in New Zealand, Walton (1974) determined that a 2-queen system used less equipment and less apiary working time per unit of honey produced. However, Walton's study did not set monetary values to these 2 economic measurements.

Recent studies of honey bee management in British Columbia have addressed economic concerns. Scott and Winston (1985) reported that the highest gross income was associated with colonies managed intensively for pollination, honey production, and bee production. Winston *et al.* (1985) found that shaking packages from overwintered colonies increased profits. In both of the British Columbia studies, colonies of honey bees were most profitable when managed intensively.

Although the above comparisons did not use complete economic analyses, other reports have been issued that more thoroughly address the costs and returns of commercial honey production. These reports have often used a sample of beekeepers to obtain consensus costs and returns (Robertson, 1960; Owens *et al.*, 1973; British Columbia, 1979; Andruchow, 1982; MacDonald and Monner, 1984; Murrell, 1988).

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Other investigators have analyzed commercial operations of different sizes. Reed and Horel (1976) compiled an economic analysis for a 1000 and a 3000 colony operation. Sanford (1986), in a study designed to help mid-size honey producers better understand costs of and returns from their operations, analyzed the profitability of a 500 colony operation.

In this paper, we examine economic considerations that may be important to sideline and commercial honey producers.

MATERIALS AND METHODS

The experimental design, the 3 management system treatments [2, single season package colonies (2 PK); vertical 2-queen (V2Q); and horizontal 2-queen (H2Q)], and the methods of management for each system were described elsewhere (Duff and Furgala, 1989).

Enterprise budgets are used by producers in management decisions and in planning for the future (Boehlje and Eidman, 1984). Enterprise budgets for each 2-queen management system were developed for the economic analysis of this experiment. These budgets used receipt and cost estimates based on a single owner operator with a 500 2-queen unit operation. Budgets for each system included gross receipts, operating costs, and ownership costs. Returns from each system were calculated.

Gross Receipts

The gross receipts from each of the 3 systems (2PK, H2Q, V2Q) were determined by the quantity and price of honey and beeswax produced.

The quantity of surplus honey was determined by calculating the difference in colony weight before and after harvest. Data from the 3 apiaries were combined to obtain the mean quantity of surplus honey produced by each system. Quantity of beeswax was estimated as 1.5% of the quantity of honey. The average net price of white honey (\$0.642/lb) was determined from the 1986-1987 Commodity Credit Corporation loan rates minus the National Honey Board assessment. The price of beeswax was estimated at \$0.90/lb.

Operating Costs

Quantities in each budget reflected the requirements of

each system. All systems were assumed to require the same number of apiaries and be located the same distance from the operator's base. Prices of budgeted items were estimated from vendor price lists (1986-1987).

The 2PK system requires the annual purchase of 2 packages of worker honey bees. The price of one of these 2-pound queenless packages, including shipping, was estimated at \$17.00. The budget included a 10% allowance to cover the loss of package colonies after hiving.

Queens were purchased for all 3 systems. The 2PK system required 2.2 queens per 2-queen experimental unit. The V2Q and H2Q systems required 1.1 per 2-queen unit. Star-line queen prices were estimated at \$6.00 each. Budgets included a 10% queen loss allowance for all 3 systems.

The amount of sugar fed varied among systems. The 2 package colonies (2PK) were fed 26.5 lbs. of sucrose in the spring. Divisions of the V2Q and H2Q systems were fed 3.3 lbs. of sucrose in the spring, plus an additional 15 lbs. in the fall. The price of granulated sucrose was estimated at \$0.28/lb.

Two lbs. of pollen substitute (soyflour, brewers yeast, and dry skim milk powder; 3:1:1, by wt.) mixed with honey were fed to each overwintered colony (V2Q, H2Q). The price of this mixture was estimated at \$0.73/lb.

A chemotherapeutic program was used for all 3 systems. Fumagillin (0.19 g) was fed to all colonies. The price of fumagillin was estimated at \$6.32/gm. Oxytetracycline hydrochloride (TM) was applied with powdered sugar to all colonies. Two gms of TM were applied to the 2PK and H2Q systems and 1.5 gms to the V2Q system. Price of the TM/powdered sugar mixture was estimated at \$0.40/gm of active ingredient.

Supplies (smokers, veils, hive tools, suits, and gloves) and other miscellaneous equipment were needed for all management systems. A cost of \$200/year, or \$0.40 per 2-queen unit, was budgeted.

Since the same number of locations would be used for all systems, goodwill donations to landowners were budgeted at \$1.00/2-queen unit.

Cost of utilities (honey house and extracting equipment) was estimated at \$1500/year for all 3 management systems, or \$3.00/2-queen unit.

Cost of freight to deliver honey was estimated at \$0.01/lb.

Labor costs accounted for a large proportion of the total operating costs. These costs were broken down into apiary labor, extracting labor, and miscellaneous labor. Apiary labor was based on the number of necessary trips and the working time in the apiary. Apiary labor for the 2PK system was estimated at 1.38 hrs./2-queen unit, the V2Q system at 1.32 hrs./2-queen unit, and the H2Q system at 1.50 hrs./2-queen unit. The beekeeping methods used for each system were outlined in Part I (Duff and Furgala, 1989). Extracting labor was estimated at 0.33 hrs./2-queen unit for the 2PK and V2Q systems. Extracting labor for the H2Q system was estimated at 0.36 hrs./2-queen unit to account for the greater number of honey supers used. Miscellaneous labor (driving, truck loading, preparation, and clean up time) was estimated at 1.7 hrs./2-queen unit for all systems. The price of labor, including all compensation, was estimated at \$9.00/hr.

Truck operating costs (fuel, oil, repairs, and maintenance) depended on the number of trips and distance to apiaries. The 2PK system required a minimum of 15 visits/yr., the V2Q system 17, and the H2Q system 18. Distance to yards was estimated at 2 miles/2-queen unit/visit. Operating cost/mile was estimated at \$0.15.

Miscellaneous costs (state registration of colonies, publications, memberships, and professional meetings) for all systems were budgeted at \$1.00/2-queen unit.

Interest on operating capital was set at 12% and was calculated for 6 months (half year convention).

Ownership Costs

Ownership costs were based on estimates of replacement cost (Boehlje and Eidman, 1984). Hive, truck, extracting equipment, and building costs were included. Although hive costs varied with the amount of equipment used, the truck,

Table 1. Estimates of hive ownership costs for 3 management systems.

| Items | Price | Management System | | |
|---|---------|--------------------------|------------------------|--------------------------|
| | | 2 Package Colonies (2PK) | Vertical 2-queen (V2Q) | Horizontal 2-queen (H2Q) |
| Hive bodies | \$12.00 | (4) \$ 48.00 | (4) \$ 48.00 | (5) \$ 60.00 |
| Med. supers | 10.00 | (9) 90.00 | (9) 90.00 | (10) 100.00 |
| Out. covers | 6.00 | (2) 12.00 | (1) 6.00 | (2) 12.00 |
| In. covers | 2.00 | (2) 4.00 | (1) 2.00 | (2) 4.00 |
| Bot. boards | 3.00 | (2) 6.00 | (1) 3.00 | (2) 6.00 |
| Hive stands | 1.75 | (2) 3.50 | (1) 1.75 | (2) 3.50 |
| Q. excluders | 4.10 | (1) 4.10 | (1) 4.10 | (0.4) 1.64 |
| D. screens | 2.50 | (1) 2.50 | (1) 2.50 | |
| W. cartons | 4.00 | (1) 4.00 | (1) 4.00 | (1) 4.00 |
| | | 163.50 | 161.35 | 191.14 |
| Annual depreciation (based on 20 yr.) | | 8.18 | 8.07 | 9.56 |
| Interest (5% on avg. of replacement cost) | | 4.09 | 4.04 | 4.78 |
| Insurance (1% of replacement cost) | | 1.64 | 1.61 | 1.91 |
| Total hive ownership costs | | 13.91 | 13.72 | 16.25 |

extracting equipment, and building costs were assumed to be the same for all 3 management systems.

Budgeted costs for hive equipment are shown in Table 1. The 2PK and V2Q systems required 4 deep hive bodies per 2-queen unit, the H2Q system used 5. The replacement cost of a complete hive body was estimated at \$12.00. The 2PK and V2Q systems used 9 medium honey supers, while the H2Q system used 10 honey supers/2-queen unit. The price of a complete honey super was estimated at \$10.00. The 2PK and H2Q systems required 2 outer covers, 2 inner covers, 2 bottom boards, and 2 hive stands per 2-queen unit, while the V2Q systems used but one of each. Costs (manufactured by owner) for outer covers, inner covers, bottom boards, and hive stands were estimated at \$6.00, \$2.00, \$3.00, and \$1.75, respectively. Queen excluders were used in the V2Q system (one/2-queen unit). In the H2Q system, queen excluders can be used for finding queens on more than 2 units when divisions are made (0.4/2-queen unit). The price of a metal excluder was estimated at \$4.10. Double screens were used in each V2Q unit, with the price of a screen estimated at \$2.50. A commercial cardboard winter carton was used

Table 2. Mean quantity of surplus honey produced in colonies managed as 2-queen unit systems in 3 apiaries, St. Paul, MN 1986-1987.

| Treatment | | Quantity of surplus honey [lbs.] |
|--------------------------|----------|----------------------------------|
| 2 Package colonies (2PK) | (n = 30) | 241.9 (10) b |
| Vertical 2-queen (V2Q) | (n = 30) | 236.4 (11) b |
| Horizontal 2-queen (H2Q) | (n = 29) | 281.9 (14) a |

Mean \pm (SE); Means within the column followed by the same letter are not significantly different ($P > 0.05$; Student-Newman-Keuls' test).

Table 3. Honey Production; 2 package colonies managed as an annual 2-queen unit (2PK) system in Minnesota.

| Item | Unit | Qty. | Price or Cost/Unit | Value or Cost |
|--|------|-------|--------------------|---------------|
| Gross receipts | | | | |
| Honey | Lbs. | 241.9 | \$ 0.642 | \$155.30 |
| Beeswax | Lbs. | 3.6 | 0.90 | 3.24 |
| Total receipts | | | | \$158.54 |
| Operating costs | | | | |
| Bees | Pkg. | 2.2 | 17.00 | 37.40 |
| Queens | No. | 2.2 | 6.00 | 13.20 |
| Sugar | Lbs. | 26.5 | 0.28 | 7.42 |
| Pollen substitute | Lbs. | - | - | - |
| Fumagillin | Gms. | 0.19 | 6.32 | 1.20 |
| Oxytetracycline | Gms. | 2.0 | 0.40 | 0.80 |
| Supplies | Dol. | | | 0.40 |
| Goodwill for location | Dol. | | | 1.00 |
| Utilities | Dol. | | | 3.00 |
| Freight | Dol. | 241.9 | 0.01 | 2.42 |
| Labor | | | | |
| Apiary | Hrs. | 1.38 | 9.00 | 12.42 |
| Extracting | Hrs. | 0.33 | 9.00 | 2.97 |
| Misc. | Hrs. | 1.7 | 9.00 | 15.30 |
| Truck operating | Mi. | 30.0 | 0.15 | 4.50 |
| Misc. expense | Dol. | | | 1.00 |
| Interest on operating capital | Dol. | | 0.12 | 6.18 |
| Total operating costs | | | | \$109.21 |
| Income above operating costs | | | | 49.33 |
| Ownership costs | | | | |
| Depreciation, interest, insurance on hives | Dol. | | | 13.91 |
| Depreciation, interest, insurance on 2 trucks | Dol. | | | 12.17 |
| Depreciation, interest, repairs, insurance on extracting equipment | Dol. | | | 4.20 |
| Depreciation, interest, repairs, taxes, and insurance on buildings | Dol. | | | 10.50 |
| Total ownership costs | | | | 40.78 |
| Total costs shown | | | | \$149.99 |
| Net returns above costs shown | | | | 8.55 |

on each division in the V2Q and H2Q systems and was priced at \$4.00

Annual depreciation was calculated for each treatment using the straight line method for 20 years with no salvage value. Interest was calculated at a 5% real rate on the average value of the hives for their projected life. This was equivalent to 2.5% of the replacement cost. Insurance for the equipment was estimated at 1% of the replacement cost.

Truck ownership costs included depreciation, interest, taxes, and insurance. All management systems were assumed to have 2 vehicles, with a total basis of \$30,000. Depreciation was calculated for 7 years, straight line, with no salvage value. Interest was calculated at a real rate of 5%, for the average value (\$15,000) during the life of the vehicles. This cost was estimated at \$1.50/2-queen unit. Taxes and insurance were set at 7% of the average value (\$15,000) during the life of vehicles, or \$2.10/2-queen unit.

The replacement value of the extracting equipment (uncapper, extractor, spinner, melter, pumps, and other equip-

ment) was estimated at \$20,000. Straight line depreciation was calculated on a 20 year life with no salvage value, or \$2.00/2-queen unit. Interest was calculated with a real rate of 5% based on the average value (\$10,000) during the 20 year life, or \$1.00/2-queen unit. Repairs and maintenance were set at 2% of replacement cost, or \$0.80/2-queen unit. Insurance was calculated at 1% of replacement cost, or \$0.40/2-queen unit.

The ownership costs for buildings included depreciation, interest, repairs, taxes, and insurance. The replacement cost of buildings was estimated at \$50,000. Depreciation was calculated for a 20 year life with no salvage value (5%/year). A 5% real rate of interest was used for the average value of buildings for their life (half of the stated rate = 2.5%). Repairs, taxes, and insurance were set at a total of 3% of replacement cost. Total annual building costs (10.5%) were estimated at \$5,250, or \$10.50/2-queen unit.

Net Returns Above Costs Shown

The net returns above costs shown were calculated for each 2-queen unit. The combined data from the 3 apiaries

Table 4. Honey Production; Overwintered colony managed as a perennial Vertical 2-queen unit (V2Q) system in Minnesota.

| Item | Unit | Qty. | Price or Cost/Unit | Value or Cost |
|--|------|-------|--------------------|---------------|
| Gross receipts | | | | |
| Honey | Lbs. | 236.4 | \$0.642 | \$151.77 |
| Beeswax | Lbs. | 3.5 | 0.90 | 3.15 |
| Total receipts | | | | \$154.92 |
| Operating costs | | | | |
| Bees | Pkg. | - | - | - |
| Queens | No. | 1.1 | 6.00 | 6.60 |
| Sugar | Lbs. | 18.3 | 0.28 | 5.12 |
| Pollen substitute | Lbs. | 2.0 | 0.73 | 1.46 |
| Fumagillin | Gms. | 0.19 | 6.32 | 1.20 |
| Oxytetracycline | Gms. | 1.5 | 0.40 | 0.60 |
| Supplies | Dol. | | | 0.40 |
| Goodwill for location | Dol. | | | 1.00 |
| Utilities | Dol. | | | 3.00 |
| Freight | Dol. | 236.4 | 0.10 | 2.36 |
| Labor | | | | |
| Apiary | Hrs. | 1.32 | 9.00 | 11.88 |
| Extracting | Hrs. | 0.33 | 9.00 | 2.97 |
| Misc. | Hrs. | 1.7 | 9.00 | 15.30 |
| Truck operating | Mi. | 34.0 | 0.15 | 5.10 |
| Misc. expense | Dol. | | | 1.00 |
| Interest on operating capital | Dol. | | 0.12 | 3.48 |
| Total operating costs | | | | \$ 61.47 |
| Income above operating costs | | | | 93.45 |
| Ownership costs | | | | |
| Depreciation, interest, insurance on hives | Dol. | | | 13.72 |
| Depreciation, interest, insurance on 2 trucks | Dol. | | | 12.17 |
| Depreciation, interest, repairs, insurance on extracting equipment | Dol. | | | 4.20 |
| Depreciation, interest, repairs, taxes, and insurance on buildings | Dol. | | | 10.50 |
| Total ownership costs | | | | 40.59 |
| Total costs shown | | | | \$102.60 |
| Net returns above costs shown | | | | 52.86 |

were analyzed (ANOVA) using unbalanced data sets. Treatment means were separated by the Student-Newman-Keuls' procedure.

RESULTS AND DISCUSSION

The H2Q system 2-queen units produced significantly more surplus honey than did the 2 PK and V2Q system 2-queen unit ($P < 0.05$) (Table 2). The amount of wax produced by each 2-queen system differed by less than one lb.

Enterprise budgets for the 2PK, V2Q, and H2Q systems are presented in Tables 3, 4, and 5, respectively.

The H2Q system generated the highest gross receipts. The 2PK and V2Q system receipts were lower. An operator with 500 H2Q system 2-queen units would gross over \$92,000 with the given honey yields and prices. The same number of 2PK and V2Q system 2-queen units would gross over \$79,000 and \$77,000, respectively.

The highest operating costs were associated with the 2PK system (Table 3). The high cost of package bees, twice the

number of queens, and more feeding increased the total operating costs. The operating costs of the V2Q system were substantially lower than the 2PK system and slightly lower than the H2Q system. The V2Q system budget resulted in the lowest labor cost. Labor, freight, and truck operating costs were highest for the H2Q system.

Except for depreciation, interest, and insurance on hives (Table 1), the same ownership costs were budgeted for all 3 treatments. Replacement costs for hives were highest for the H2Q system, because one extra hive body and one extra honey super were used per 2-queen unit.

The 2PK system exhibited the highest total costs (\$149.99) per 2-queen unit. The total cost of the V2Q and H2Q systems were much less (\$102.06, and \$107.61).

Net returns above costs shown differed significantly among treatments ($P < 0.5$). The H2Q system netted \$77.15, the V2Q system \$52.86, and the 2PK system \$8.55 (Table 6). On a 500 2-queen unit basis, net returns above costs shown would range from \$4,275 to \$38,575. The costs shown do

Table 5. Honey Production; Overwintered colony managed as a perennial Horizontal 2-queen unit (H2Q) system in Minnesota.

| Item | Unit | Qty. | Price or Cost/Unit | Value or Cost |
|--|------|-------|--------------------|---------------|
| Gross receipts | | | | |
| Honey | Lbs. | 281.9 | \$0.642 | \$180.98 |
| Beeswax | Lbs. | 4.2 | 0.90 | 3.78 |
| Total receipts | | | | \$184.76 |
| Operating costs | | | | |
| Bees | Pkg. | | | |
| Queens | No. | 1.1 | 6.00 | 6.60 |
| Sugar | Lbs. | 18.3 | 0.28 | 5.12 |
| Pollen substitute | Lbs. | 2.0 | 0.73 | 1.46 |
| Fumagillin | Gms. | 0.19 | 6.32 | 1.20 |
| Oxytetracycline | Gms. | 2.0 | 0.40 | 0.80 |
| Supplies | Dol. | | | 0.40 |
| Goodwill for location | Dol. | | | 1.00 |
| Utilities | Dol. | | | 3.00 |
| Freight | Dol. | 281.9 | 0.01 | 2.82 |
| Labor | | | | |
| Apiary | Hrs. | 1.50 | 9.00 | 13.50 |
| Extracting | Hrs. | 0.36 | 9.00 | 3.24 |
| Misc. | Hrs. | 1.7 | 9.00 | 15.30 |
| Truck operating | Mi. | 36.0 | 0.15 | 5.40 |
| Misc. expense | Dol. | | | 1.00 |
| Interest on operating capital | Dol. | | 0.12 | 3.65 |
| Total operating costs | | | | \$ 64.49 |
| Income above operating costs | | | | 120.27 |
| Ownership costs | | | | |
| Depreciation, interest, insurance on hives | Dol. | | | 16.25 |
| Depreciation, interest, insurance on 2 trucks | Dol. | | | 12.17 |
| Depreciation, interest, repairs, insurance on extracting equipment | Dol. | | | 4.20 |
| Depreciation, interest, repairs, taxes, and insurance on buildings | Dol. | | | 10.50 |
| Total ownership costs | | | | 43.12 |
| Total costs shown | | | | 107.61 |
| Net returns above costs shown | | | | 77.15 |

