AGRONOMIC AND ECONOMIC EVALUATION OF ULTRA NARROW ROW COTTON PRODUCTION IN ARIZONA 1999-2000

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Abstract

Ultra Narrow Row (UNR) and conventional (CNV) cotton production systems were compared with respect to agronomic practices, yield, fiber quality, and production costs in experiments conducted in 1999 and 2000 in central Arizona. Cotton rows were 10 and 40 inches apart in the UNR and CNV systems, respectively. In 1999, the average lint yield in the UNR system, 1334 lb/A, was significantly greater than the 1213 lb/A yield of the CNV system. Similar results were obtained in 2000 with yields of 1472 and 1439 lb/A for the UNR and CNV systems, respectively. Fiber grades of both systems were comparable with most bales receiving a grade of 21 in 1999. The average bale grades in 2000 were 11 and 21 in the UNR and CNV systems, respectively. The quality of the fiber produced in both systems was also comparable with staple and strength measurements meeting base standards in both years. However, there was a consistent difference between the UNR and CNV systems in both years with respect to micronaire. Micronaire averaged 4.5 and 4.0 in the UNR system in 1999 and 2000, respectively, and 5.0 and 4.9 in the CNV system in 1999 and 2000, respectively. Variable growing costs were $607 and $446 for the UNR system in 1999 and 2000, respectively, and $660 and $519 for the CNV system in 1999 and 2000, respectively. Harvest and post-harvest variable costs were $234 and $209 in the UNR system in 1999 and 2000, respectively, and $217 and $224 in the CNV system in 1999 and 2000, respectively. The economic data indicated that the UNR system reduced production costs and increased profitability without sacrificing lint yield or quality. However, these experiments also indicated that many production challenges such as planting and obtaining adequate plant populations, managing plant height control, and weed control need further study.

Introduction

Flat cotton prices and rapidly rising production costs are prompting producers to seek opportunities to reduce costs and increase net returns. The ultra narrow row (UNR) cotton production system is of commercial interest due to its potential to reduce costs while still producing acceptable fiber quality and yield. The UNR system by definition uses row spacing of 20 inches or less and high plant populations, generally 100,000 to 120,000 plants per acre. A potential advantage of the UNR production system includes increased light capture and greater photosynthetic efficiency that maximizes carbohydrate production for boll initiation and growth early in the season.

The objectives in a UNR cotton system are to promote early fruiting, control vegetative growth, enhance earliness, and eliminate late season costs by reducing season length. The length of the season can be reduced by setting a limited number of bolls per fruiting branch and develop fewer fruiting branches per plant at high plant populations compared to typical fruiting patterns in conventional planting densities. The ability to produce an economically viable lint yield with acceptable fiber quality on fewer fruiting branches may reduce costs by eliminating late season irrigations, and reducing insecticide and fertilizer applications. Costs may be further reduced due to the lower cost of stripper harvesters compared to spindle harvesters and by the lower cost of harvesting with a stripper harvester.

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The UNR cotton production system was tried in Arizona in the 1970's but was abandoned due to the inability to control weeds and manage cotton plant height in a high plant population scenario. In recent years, UNR production has been the subject of renewed interest in the South and Southeastern regions of the United States cotton belt. The availability of selective over the top herbicides, transgenic herbicide resistant cotton varieties, and plant growth regulators for height control have enabled research and grower experience to gain momentum. Prior to 1998, no recent commercial or research evaluation of UNR cotton production was conducted in Arizona.

Methodology

Experiments conducted in 2000 were designed to compare conventional and ultra narrow row cotton production systems in terms of yield, fiber quality, and production costs using the methodology of Husman et. al. (2000). Other objectives were to identify critical differences in production practices between systems and to gain familiarity with successful UNR cotton production.

An experiment was conducted in 2000 on a commercial farm in Coolidge, Arizona using a complete block design with four blocks. Each complete block contained two treatments; a conventional 40-inch row system on furrow irrigated beds and a 10-inch row UNR system planted in level, flood irrigated borders. Each system or treatment within a block was 40 feet wide by the length of the irrigation run which was 800 feet. The conventional 40-inch row system was managed using the grower's standard farm practices. The cultural operations and inputs used in UNR system were provided by the cooperating producer at the request of the authors. The conventional system plots were treated with 1.7 pt of Prowl 3.3/A and 1.7 pt of Caparol/A that was incorporated prior to bed formation. The UNR system plots were also treated with 1.7 pt of Prowl 3.3/A that was also incorporated prior to planting but Caparol was not used. Delta Pine 451BR was planted dry and irrigated up in both systems on April 27, 2000. The conventional system plots consisted of twelve 40 in rows planted at a seeding rate of 11 lb/A with a six row John Deere 7200 Max Emerge vacuum planter. The UNR plots were planted at a 34 lb/A seeding rate in 10 in rows with a Kinze double tool bar planter with staggered planter boxes. Due to soil crusting and inadequate emergence, the UNR system plots were replanted with Delta Pine 422 BR at a seeding rate of 34 lb/A into existing soil moisture (i.e., wet planted) on May 9 with a Monosem precision air planter in 10 inch rows. Stand counts taken on June 19 were 37,250 and 120,000 plants/A in the conventional and UNR systems, respectively.

The conventional and UNR plots were irrigated on the same dates (Table 1). Irrigation efficiency was greater in the level basin UNR borders compared to the conventional plots resulting in less water being applied per irrigation in the UNR system. Although both production systems received a total of 10 irrigations, 47 and 37 acre inches were applied to the conventional and UNR systems, respectively. Post-establishment irrigations were initiated on 1 June and terminated on 16 August for both systems. Nitrogen in the form of URAN 32 was applied in the irrigation water. The UNR system received nitrogen on 1 June, 15 June, and 18 July for a total of 78 lbs. of nitrogen/A. The conventional system received nitrogen on 19 May, 13 June, and 27 June for a total of 222 lbs. of nitrogen/A. In addition to the previously discussed pre-plant incorporated herbicide applications, both system treatments received a 1 qt of Roundup Ultra/A plus 17 lb of AMS/A at the 2 true-leaf cotton growth stage. Since a second topical Roundup Ultra application was not made prior to the 4 true-leaf cotton growth stage, there were some morningglory plants that were not killed by the herbicide treatments which were removed by a hand weeding crew.

PIX was applied on 30 June, 5 July, 16 July, and 24 July for a cumulative total of 48 oz/A to manage plant height in the UNR system. The conventional system received one 12 oz/A PIX application on 5 July. Insect populations were managed similarly in both systems except that the conventional system received an in furrow granular insecticide/fungicide (disyston + terraclor) application at planting. Five postemergence insecticide applications were required to control lygus and low levels of whiteflies (Orthene 18 July and 26 July, Phaser 2 Aug., Othene + Ammo 11 Aug., Vydate 23 Aug.). Both systems were defoliated with a tank-mix of 8 oz of Ginstar /A and 2 pt of Prep/A applied with a John Deere 6000 Hi-Cycle on 14 September. The UNR system received a second defoliant application, 2 pt of Starfire /A, on 26 September to desiccate the crop and facilitate stripper harvest.

The conventional system plots were harvested on 10 October by picking all 12 rows of each plot using a 6 row John Deere 9976 spindle picker. The UNR system was harvested on 20 October using a John Deere 7455 equipped with a 14 foot S and H finger stripper header. A round was made in each UNR plot. Seed cotton weights for each of the four plots (i.e., replicates) were measured using a Caldwell boll buggy equipped with weighing load bars on the axle and tongue. After weighting, stripper or spindle picked cotton were dumped into separate module builders resulting in a single module each of UNR cotton and conventional cotton. Each module was ginned separately by the River Cooperative Gin, Coolidge, Arizona in order to obtain accurate lint turnout values. Each full bale was sampled by the gin in a commercial manner and sent to the USDA Cotton Classing Office in Phoenix, Arizona for grade and High Volume Instrument (HVI) classing.

Two small supplemental field experiments were conducted in 2000 to investigate weed control options in UNR cotton production systems. An experiment conducted in a commercial UNR field near Stanfield, Arizona used a randomized complete block design with 4 blocks to compare an untreated control with preemergence applications of Prowl at 1.8, 2.4, or 3.0 pt/A and a tank-mix application of Prowl and Caparol at 2.4 and 1.5 pt/A, respectively. Plots were 20 feet wide by the length of the field, 930 feet. The broadcast preemergence herbicide treatments were applied on April 13, 2000 using a 20 foot boom with XR8002VS nozzles spaced 20 inches apart calibrated to deliver 15 gallons of water/A. The sky was clear at the time of application, the air temperature was 91.3 F, the soil surface temperature was 97 F and there was a 2.7 mph breeze. The field was planted with a Great Plains Planter set on a 10 in row spacing and irrigated twice in the week after the herbicide applications but an adequate stand was not obtained. The field was replanted by drilling the seed into existing soil moisture (i.e., wet planted). All treatments in the Stanfield experiment received topical applications of Roundup Ultra at 1 qt/A plus ammonium sulfate at 17 lb/100 gallon at the 2 leaf and 6 leaf cotton growth stage. The second weed control experiment was conducted at the University of Arizona Maricopa Agricultural Center (MAC) near Maricopa, Arizona. A randomized, complete block design with four blocks and a plot size of 20 by 50 feet was used to evaluate weed control in plots that received no preplant preemergence herbicide compared to plots that received either a preemergence herbicide application or a preplant, incorporated preemergence herbicide application. Unfortunately, this experiment had to be replanted three times necessitating the use of a field cultivator prior to the replanting and several irrigations. Thus, all treatments except the untreated control became preplant, incorporated herbicide treatments. The third and final planting was done on May 8 with a Monosem precision air planter as described above. Weed control in both experiments was visually evaluated several times during the season. Due to the lack of positive results, the experiment at Stanfield was bulk picked while the experiment at MAC was not harvested due to the lack of a stripper plot harvester.

Results and Discussion

In 1999, the UNR system produced 121 lb of lint/A more than the conventional row spacing (CNV) system (Table 2; see also Husman et. al., 2000). Similarly, in 2000, the UNR system yield of 1472 lb/A was significantly greater than the CNV yield of 1439 lb/A although the difference between the systems, 33 lb/A, was smaller than in 1999 (Table 4). The growing costs in 1999 were $606.52 and $671.92 for the UNR and CNV systems, respectively (Table 3). Adding the additional variable costs associated with defoliation, harvest, ginning, and classing resulted in total variable costs of $877.69 and $929.49 for the UNR and CNV systems, respectively, for a difference of $51.80. Similar results were obtained in the 2000 experiment where the growing costs were $446.19 and $518.81 for the UNR and CNV systems, respectively (Table 5). Adding the additional variable costs associated with defoliation, harvest, ginning, and classing, resulted in total variable costs of $695.45 and $791.37 for the UNR and CNV systems, respectively, for a difference of $95.92. The lower variable costs of the UNR system coupled with the yield difference would result in $119.02/A more revenue in the UNR system using a $0.70 cotton price. This increased revenue does not account for any value associated with differences in grade, micronaire, or other fiber qualities. Using the measured yields and production costs, the total 2000 variable cost per unit of production (i.e., lb of lint) was $0.47 and $0.55 for the UNR and CNV systems, respectively (Table 5).

Although stripper harvested cotton is often stigmatized by the perception of low quality cotton, the UNR fiber quality was excellent in both the 1999 and 2000 experiments (Tables 2 and 4). In 1999, both the UNR and CNV bales had grades of 21 and staple measurements of 36. In 2000, the majority of bales from the UNR module had a grade of 11 while the CNV bales had a grade of 21. In 1999, the UNR cotton had an average micronaire of 4.5 compared to an average micronaire of 5.0 for the CNV (Table 2). In 2000, the micronaire readings averaged 4.0 in the UNR samples compared to an average micronaire of 4.9 for the CNV cotton (Table 4). The 2000 staple ratings were acceptable in both systems with a 35 and 36 in the UNR and CNV systems, respectively (Table 4). A trend of high and increasing micronaire in recent years has become a problem in conventional cotton production systems resulting in significant price discounts in Arizona. Therefore, the reduced micronaire of UNR cotton in 1999 and 2000 was a positive result with potential economic benefits to Arizona producers.

While the yield, fiber quality, and production cost results from both 1999 and 2000 experiments were quite encouraging, our research and cooperating growers experiences highlighted a number of major challenges that must be overcome before UNR production practices will be widely adopted. The UNR production system is radically different than the conventional row spacing system that has been refined over many decades by commercial producers and scientists. Many research issues such as variety selection, cultural practices, nutritional practices, plant growth regulator use, weed control and irrigation management need to be addressed before producers will have a similar production comfort level with UNR as they do with conventional systems. However, assuming that the above issues are addressed with time, there are three major challenges that must be overcome if UNR cotton production is to account for any significant acreage in Arizona. These three challenges are successful establishment of high density, uniform plant populations, obtaining adequate weed control, especially annual morningglory control, and consistently reducing season length to predictably reduce production costs.

The 2000 agronomic experiment in Coolidge, Arizona and the weed control experiment at the MAC were initially planted using a Kinze double tool bar planter designed for UNR planting with a row spacing of 10 inches. The planter units resemble John Deere 7100 units with a plate-less design. The first stand establishment attempts were dry plants in level basins that were irrigated to germinate the seed. The soils at these sites were quite sandy with moderate crusting potential. In the Coolidge experiment, the initial stand was not uniform and was estimated to be approximately a 70% establishment. Similar results were obtained in the weed control experiment at the MAC where the soil contained 54% sand, 22% silt, 24% clay and 1.06% organic matter except that the initial stand was much poorer. The Kinze planter did not meter seeds within the seed row with any precision resulting in variable seed spacing and its depth control was imprecise. These equipment characteristics combined with the crusting potential of Arizona's coarse textured, low organic matter soils resulted in the poor stands. Even with a satisfactory planter and a sandy soil, crusting in Arizona's low organic matter soils makes obtaining an adequate, uniform plant population very difficult if not impossible when dry planting in level basins. Subsequently, a Monosem air planter (courtesy of Monosem and Keith Equipment, Casa Grande, AZ.) was used to replant the experiments. This planter has singulator planting units allowing for very precise seed spacing within the seed row. The seed was planted into existing soil moisture approximately 2 inches deep and the seed line was covered with a loose soil mulch. The resultant stand was uniform with a final plant population of 120,000 plants per acre. The Monosem planter is quite expensive compared to a traditional planter, but it is the author's view that high density, uniform populations are the cornerstone of the UNR system and must not be compromised if the system potential is to be realized. Attempts to cut corners and use existing or modified traditional planters may lead to failure.

The second critical UNR production challenge is weed control. The weed control experiment near Stanfield, Arizona compared an untreated control with preemergence applications of Prowl at 1.8, 2.4, or 3.0 pt/A and a tank-mix application of Prowl and Caparol at 2.4 and 1.5 pt/A, respectively. The experiment was evaluated several times early in the season, both before and after topical Roundup Ultra applications and it was never possible to distinguish the untreated control from any of the other treatments. Similar results were obtained in another 2000 UNR weed control experiment in Harquahala Valley (personnel communication P.A. Clay and W.B. McCloskey). The UNR weed control experiment at the MAC compared an untreated control with preplant incorporated (PPI) applications of Prowl (1 lb a.i./A) and Treflan (0.75 lb a.i./A) with all treatments receiving a topical Roundup Ultra application (1 qt/A plus 17 lb of AMS/100 gal) at the 3 to 4 leaf growth stage. These treatments were evaluated after defoliation and the percentage of the cotton canopy containing morningglory vines was visually estimated. The percentages of the cotton canopies containing morningglory vines in the untreated control and the PPI Prowl and Treflan treatments were 67, 6, and 18%, respectively. The difference between the Prowl and Treflan treatments was not significant. These results combined with results obtained in 1999 (McCloskey et. al., 2000) indicate that preemergence herbicides must be mechanically incorporated prior to planting to be effective in UNR systems, particularly in helping to suppress annual morningglory emergence.

A major reason for the recent increase in interest in UNR cotton production is the development of herbicide resistant cotton varieties that allow topical herbicide applications. The most commonly chosen cotton varieties contain the glyphosate resistance or Roundup Ready gene. The current label permits up to two topical Roundup applications from emergence through the 4 true-leaf growth stage (i.e., fifth leaf less that the size of a quarter). Annual morninggglory species are some of the more pervasive weed species in Arizona and have the ability to germinate and develop under low light conditions. In practice, it is very difficult if not impossible to apply two topical Roundup applications prior to the 4th true leaf growth stage when cotton is wet planted although it is possible in dry plant scenarios. Research and producer experience has shown that two topical herbicide applications, either Roundup alone or tank-mixes or premixes of Roundup plus Staple do not adequately control annual morningglory species particularly in fields with areas that are heavy infested. Non-uniform or patchy cotton stands with open areas in the canopy exacerbate the problem. Thus, it is the author's view that fields with significant potential annual morningglory pressure are not suitable candidates for UNR cotton production due limitations in current weed control technology. Second generation Roundup Ready cotton varieties with enhanced tolerance and other weed control technologies under development hold the promise for better UNR weed control in the future.

The third UNR production challenge is earliness. A fundamental factor driving UNR interest is the ability to produce a few bolls per plant in conjunction with a high plant population. This enables producers to reduce the production time necessary because fewer fruiting branches need to be produced to obtain yields comparable to conventional cotton. In addition to reducing tillage and labor costs, the UNR system theoretically allows producers to eliminate some late-season costs by reducing season length. To date, both the commercial UNR production experience in Arizona as well as our research projects have not resulted in significantly reduced season length. However, we think that this goal is both critical and is likely attainable. The 2000 replanting operations described in this paper and the high lygus pressure in 1999 (Husman et. al., 2000) essentially minimized the potential of the UNR system for earliness. UNR experiments will be conducted again in 2001 using the planter and successful planting methodology described above. It is felt that a great deal of the production learning curve has been addressed with 2001 offering hopes to realize and measure the potential of the UNR system. Earliness is also critical in order to facilitate early defoliation, desiccation, and stripper harvest during the periods when high temperatures prevail.

Summary

The results of the 1999 and 2000 experiments were encouraging and certainly validate the need to move forward with continued research. In both years, the UNR system produced more lint that the CNV system and reduced costs. If a producer can consistently reduce the cost of production on a production unit basis, the system should be of interest independent of the current cotton price structure. Again, there are still many challenges and research issues that need to be addressed in order to fully refine the UNR system and develop commercial management recommendations. Successfully achieving high density, uniform plant populations is fundamentally important if the maximum potential of the UNR system is to be achieved. Maximizing the earliness of the UNR system and improving weed control are also important challenges that will be addressed in future research.

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Table 1. Production input summary for UNR and Conventional row spacing 1999 and 2000.

	UNR 1999	CNV 1999	UNR 2000	CNV 2000
Planting Date	30-April	30-April	9-May	27-April
Irrigation App.	7	7	10	10
Nitrogen App.	3	3	3	3
PGR App.	5	2	4	1
Insecticide App.	13	14	4	5
Herbicide App.	2	1	2	3
Harvest Date	27-October	27-October	20-October	10-October

Table 2. Lint yield by row spacing and fiber quality in 1999.

	Lint (lbs./Acre)	Grade	Mic	Staple	Strength
UNR	1334 a	21	4.5	36	27.6
CNV	1213 b	21	5.0	36	27.5
P	0.0172				
%CV	5.84				
LSD	91.0				

Table 3. Cotton production budgets for UNR and Conventional row spacing based on data collected in 1999, Maricopa, AZ.

ITEM DESCRIPTION	UNR Flats	Conventional 40" Rows	County Avg. Conventional
Area	Pinal Co. AZ	Pinal Co. AZ	Pinal Co. AZ
Irrigation System	Basin	Furrow	Furrow
Lint Yield (lbs/acre)	1,334	1,213	1,154
COSTS			
Growing Cost	($/acre)	($/acre)	($/acre)
Labor	$88.09	$98.94	$78.28
Machine Operation	$48.96	$61.18	$44.35
Irrigation	$39.13	$37.76	$33.93
Chemicals & Application	$275.21	$290.00	$208.10
Fertilizer	$30.42	$73.72	$73.72
Insecticide	$186.54	$186.54	$101.51
Herbicide	$15.49	$15.49	$18.62
Other Chemicals	$42.76	$14.25	$14.25
Machinery Fuel & Repairs	$52.84	$65.03	$52.15
Diesel	$20.12	$25.38	$19.17
Repairs	$32.72	$39.65	$32.98
Irrigation Water w/o Assessment	$157.50	$205.50	$187.50
Seed & Transplants	$32.88	$12.45	$12.45
Total Growing Cost	$606.52	$671.92	$538.48
Harvest and Post-harvest Cost			
Labor	$25.83	$25.83	$25.83
Machine Operation	$17.56	$17.56	$17.56
Other Labor	$8.27	$8.27	$8.27
Chemicals & Application	$36.64	$29.61	$28.95
Defoliant	$36.64	$29.61	$28.95
Machinery Fuel & Repairs	$41.82	$43.95	$48.47
Diesel	$7.35	$6.09	$7.12
Repairs	$34.47	$37.86	$41.35
Custom & Other Materials	$12.79	$11.77	$12.86
Ginning & Assessment	$117.41	$106.76	$101.57
Harvest and Post-harvest Cost	$234.49	$217.92	$217.68
Operating Overhead	$15.41	$15.41	$15.41
Operating Interest	$21.27	$24.24	$25.58
Total Variable Cost	$877.69	$929.49	$797.15
Ownership Cost			
Cash Overhead	$78.66	$83.29	$77.84
Capital Allocations	$89.17	$102.00	$123.35
Land Ownership	$58.77	$58.77	$58.77
Management Services	$69.31	$72.28	$65.47
Total Ownership Costs	$295.91	$316.34	$325.43
Total Costs	$1,173.60	$1,245.83	$1,122.58
BREAK-EVEN PRICE	($/unit)	($/unit)	($/unit)
to Cover Growing Cost	$0.45	$0.55	$0.47
to Cover Total Variable Cost	$0.66	$0.77	$0.69
to Cover Ownership Cost	$0.22	$0.26	$0.28
to Cover Total Cost	*$0.88*	*$1.03*	*$0.97*

Table 4. Lint yield by row spacing and fiber quality in 2000.

	Lint (lbs./Acre)	Grade	Mic	Staple	Strength
UNR	1472 a	11	4.0	35	unavailable
CNV	1439 b	21	4.9	36	unavailable
P	0.0355				
%CV	0.87				
LSD	28.6				

Table 5. Cotton production budgets for UNR and Conventional row spacing based on data collected in 2000, Coolidge, AZ.

ITEM DESCRIPTION	UNR Flats	Conventional 40" Rows	County Avg. Conventional
Area	Pinal Co. AZ	Pinal Co. AZ	Pinal Co. AZ
Irrigation System	Basin	Furrow	Furrow
Lint Yield (lbs./acre)	1,472	1,439	1,154
COSTS			
Growing Cost	($/acre)	($/acre)	($/acre)
Labor	$47.61	$62.67	$78.28
Machine Operation	$23.99	$39.05	$44.35
Irrigation	$23.62	$23.62	$33.93
Chemicals & Application	$154.76	$186.13	$208.10
Fertilizer	$23.21	$60.93	$73.72
Insecticide	$74.25	$89.35	$101.51
Herbicide	$11.66	$24.44	$18.62
Other Chemicals	$45.64	$11.41	$14.25
Machinery Fuel & Repairs	$30.32	$47.83	$52.15
Diesel	$10.05	$16.48	$19.17
Repairs	$20.27	$31.35	$32.98
Irrigation Water w/o Assessment	$84.98	$120.06	$187.50
Seed & Transplants	$128.52	$102.12	$12.45
Total Growing Cost	$446.19	$518.81	$538.48
Harvest and Post-harvest Cost			
Labor	$14.83	$13.47	$25.83
Machine Operation	$14.83	$13.47	$17.56
Other Labor			$8.27
Chemicals & Application	$36.86	$29.86	$28.95
Defoliant	$36.86	$29.86	$28.95
Machinery Fuel & Repairs	$41.09	$67.21	$48.47
Diesel	$6.45	$7.41	$7.12
Repairs	$34.64	$59.80	$41.35
Custom & Other Materials	$1.59	$1.59	$12.86
Ginning & Assessment	$114.82	$112.24	$101.57
Harvest and Post-harvest Cost	$209.19	$224.37	$217.68
Operating Overhead	$15.41	$15.41	$15.41
Operating Interest	$24.66	$32.78	$25.58
Total Variable Cost	$695.45	$791.37	$797.15
Ownership Cost			
Cash Overhead	$67.84	$82.40	$77.84
Capital Allocations	$99.97	$159.37	$123.35
Land Ownership	$38.97	$38.97	$58.77
Management Services	$55.62	$63.31	$65.47
Total Ownership Costs	$262.40	$344.05	$325.43
Total Costs	$957.85	$1,135.42	$1,122.58
BREAK-EVEN PRICE	($/unit)	($/unit)	($/unit)
to Cover Growing Cost	$0.30	$0.36	$0.47
to Cover Total Variable Cost	$0.47	$0.55	$0.69
to Cover Ownership Cost	$0.18	$0.24	$0.28
to Cover Total Cost	*$0.65*	*$0.79*	*$0.97*