REDUCTION IN LABOR REQUIREMENTS FOR BURLEY TOBACCO PRODUCTION, PART 1: PROGRESS SINCE THE 1970s

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The high labor requirements of burley tobacco production have prompted considerable mechanization interest and efforts over the years. Significant progress has been made in reducing the amount of manual labor required. Major labor reductions of the 1972–2007 era for several practices having widespread adoption and the economic effects those reductions had for burley producers are analyzed in this article, the first in a two-part series. Major mechanization developments of the era considered in the analysis include the adoption of small-bale packaging, the transition from plant beds to float-bed systems, the use of outside field-curing structures, the use of stripping wheels and similar stripping aids, and the adoption of big-bale packaging. Total labor requirements at the beginning of the era were reported at more than 300 worker-hr/acre, but were reduced a total of 157 worker-hr/acre by 2007, or more than 50%, considering the widely adopted methods. Most of the adopted practices resulted in net savings to the producer at the time, considering both labor savings and additional investment requirements. Options for potential further labor reduction and cost benefits are analyzed in the second article in this series, *Reduction in Labor Requirements for Burley Tobacco Production, Part 2: Potential.*

INTRODUCTION

The high labor requirements of burley tobacco production have prompted considerable mechanization interest and efforts over the years. Significant progress has been made in reducing the amount of manual labor required, but burley tobacco production has remained largely manual, especially for harvesting and market preparation. Labor costs typically account for more than one-third of the total variable costs of production (11). Interest in mechanization seemed to wane somewhat in the early 1990s as burley tobacco production began to transition to a predominantly migrant labor force. Mechanization interest was renewed in the mid 2000s as producers grew increasingly larger crops following the buyout legislation and the end of the federal quota system. As burley tobacco growers face continued market uncertainties and increasing concerns about labor supply and costs, serious interest continues in reducing burley tobacco production labor requirements through mechanization and other means. This article, the first in a two-part series, summarizes past significant labor reductions for burley tobacco production on the basis of mechanization and cultural developments that were, for the most part, widely adopted. The second article in the series reviews the potential for further labor reductions considering proven mechanization developments that have not been adopted to any significant extent. Key points presented in the two articles are: A) how much has labor been reduced since the 1970s era? (first article); B) how much labor can be further reduced with current opportunities? (second article); C) what are the costs and savings associated with these labor-reducing methods? (both articles).

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MAJOR LABOR REDUCTIONS SINCE THE 1970s

Table 1 summarizes major labor reductions of the 1972–2007 era for several practices having widespread adoption and the economic effects those reductions had for burley producers. Following Table 1 are paragraphs corresponding to superscript notations for the columns in the table and describing the various developments, with the columns across the table (from left to right) representing the developments in chronological order. References are cited for sources of the data. For simplicity in making comparisons, straight line depreciation and other consistent factors were used for equipment and facilities estimations. Not included were miscellaneous tractor, wagon, sprayer, chemical, and similar costs that are considered comparable and rather uniform for all these operations.

The baseline used for calculating labor reductions is the second column, which gives the mean value of a range of labor requirements reported as standard for various production activities during the hand-tying era up until the time that small bales were adopted (4). Major changes in labor requirements due to labor-reducing developments are shown in red in the table. In most cases, those reduced values initially shown in red are kept constant going from left to right across the table, as the developments were adopted by a majority of burley producers. Two exceptions were included, outside field-curing structures and the stripping wheel. In these cases, the reduced labor requirements due to the labor-reducing developments revert back to the previous higher values in subsequent columns because the developments, although being field-proven and achieving some widespread adoption initially, did not end up being widely adopted on a continuing basis. In most cases going from left to right across the table, the values for labor requirements for production activities not specifically affected by the labor-reducing development

Table 1. Summary of major burley labor and cost reductions, 1972–2007.

Item	Worker-hr/Acre								
	Plant Beds			Outdoor Bed	Greenhouse				
	1972	1972	~1990	~1993	~1993	~1994	~1995	~2000	2007
	Hand Tied[1a]	Mean Data[1]	Small Bale[2]	Plug &Transfer[3]	Direct Seed[4]	Field Cure Structure[5]	Stripping Wheel[6]	Buy Plants[7]	Big Bale[8]
Plant prod.	18–22	20.0	15.6	14[b]	3.2	3.2	3.2	2.0	2.0
Field prep.	11	11.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Transplant	30–37	33.5	27.3	11.8	4.9	4.9	4.9	4.9	4.9
Growth	20–28	24.0	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Topping + skr cnt	11–14	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Drop sticks + cut	15–21	18.0	26.0	26	26	26	26	26	26
Load + haul	8–12	10.0	8.0	8	8	8	8	8	8
House	20–25	22.5	26.0	26	26	14	26	26	26
Cure mgmt.	3	3.0	3.0	3	3	3	3	3	3
Take down + bulk	10–15	12.5	10.0	10	10	10	10	10	10
Stripping	120–140	130.0	75.0	75	75	75	39.2	75	42.7
Load + market	10–15	12.5	2.0	2	2	2	2	2	0.5
Sum worker-hr/acre:	276–343	310	223	206	188	176	152	187	153
% Incremental labor reduction[c]			−46%	−32%	−69%	−35%	−30%	−86%	−23%
% Overall labor reduction[d]			−21.2%	−4.0%	−5.7%	−3.9%	−5.5%	−3.9%	−4.1%
Net cost/lb change at the time:			−$0.095	+$0.029	−$0.086	−$0.113	−0.053	−$0.013	−$0.011

[a] Superscript numbers at the head of each column correspond to the labor-reducing developments listed and described in the text.
[b] Red numbers are for changed labor values due to labor-reducing development.
[c] Calculated from the labor reduction (shown in red) divided by the previous labor requirement. See individual tables corresponding to columns for calculations of % incremental labor reductions.
[d] Calculated from the labor reduction (shown in red) divided by the baseline total labor requirement from 1972 (second column). See individual tables corresponding to columns for calculations of % overall incremental labor reductions.
Note: Labor & Cost changes are NOT ALL ADDITIVE due to repeated use of some equipment and methods.
Standard data used: 2,500 lb/acre yield.

(and therefore not shown in red) are kept constant going forward. Several exceptions occur in the third column, which forms a new baseline for labor requirements after the adoption of small bales. These and a couple of other such exceptions are explained in the paragraphs corresponding to the columns. Overall, the data show a reduction of 157 worker-hr/acre for the widely adopted methods, or just over 50% (310 − 153/310 = 0.506), since the 1970s era.

Each paragraph describing developments has an individual table calculating the costs and savings, if any, associated with the labor-reducing development. Note that the savings associated with the reduction in labor requirements are based on a reasonable estimation of the prevailing hourly wage rates at the time of the development, converted to a per pound basis on the basis of a standard yield of 2,500 lb/acre, and summed to give a net savings (or cost) per pound of tobacco. The "% Incremental Labor Reduction" is the percent change of a labor improvement method divided by its recent value. The "% Overall Labor Reduction" is the percent change of a labor improvement divided by the 1972 base labor sum. Calculations are shown in each table's entries.

Caution: Many variations exist for producers that may limit effective adoption and utilization of the advancements described, such as excessive travel and transport of equipment, personnel, supplies, and the crop among multiple farms, varying labor costs, equipment, pre- and post-preparation time, etc. These data are not absolute values for any particular operation.

LABOR-REDUCING DEVELOPMENTS

1. Hand-Tying Era. The data for the 1972 year are from Leaflet 344, *Burley Tobacco Production Costs* (4), which are the last thorough data published before the experimentation with and adoption of the small-bale handling method. These data show a range of labor values (worker-hr/acre) and represent the typical production practices at that time. These production practices are as follows: preparing and sterilizing plant beds; sowing seed; covering beds with lightweight fabric; watering the beds if needed; hand-pulling plants; setting with the finger-type transplanters; cultivation; manual topping; applying sucker control; dropping sticks; cutting (spearing onto wooden sticks); housing; bulking after curing; stripping into four or five grades with hand-tied bundles; pressing the bundles onto sticks; later loading onto transport vehicles; traveling to warehouses; and packing onto baskets for the auction market. The next column is a mean value for the appropriate categories and is used in subsequent columns for comparative purposes. The total labor requirement was 309.5 worker-hr/acre, rounded to 310. Hand-tied tobacco in the warehouse for this era is shown in Figure 1.

Figure 1. Hand-tied tobacco in a warehouse.

Figure 2. Small-bale packages of burley tobacco.

2. Small-Bale Effect. The adoption of the small-bale for burley tobacco in the mid 1980s resulted in a significant reduction in stripping labor requirements because of the elimination of hand-tying, and it also made loading and handling for market considerably more efficient because of the larger package size. Small-bale packages of burley tobacco are shown in Figure 2. The 1990 labor data from ID-81, *Burley Tobacco: 1990 Production and Returns Guide* (9), after burley small bales were adopted, show a reduction in some plant and field production operations, apparently due to newer chemical practices and some labor variations in cultural practices, and an increase from 18 to 26 worker-hr/acre for drop sticks + cut for some unexplained reason, plus the major reduction in labor due to the small bale. Costs and savings associated with adoption of the small bale are shown in Table 2. The data show a net benefit of the small bale of −65.5 worker-hr/acre, −46% incremental, −21.2% overall, and net cost savings of −$0.095/lb per acre per year (nearly a 10¢/lb reduction). Obviously there was a considerably greater labor cost savings in later years with higher hourly labor costs adjusted for any equipment and utility changes.

3. Outdoor Beds/Float Plants. The transition from conventional plant beds (see Figure 3) to ''float plants'' (Figure 4) began in the early 1990s with gradually increasing adoption through the mid 1990s. The use of outdoor beds and the plug-and-transfer method of filling styrofoam trays with artificial media and ''plugging'' small seedlings for transplant growth were the early methods adopted. A comparison of conventional beds, outdoor plug and transfer (OP&T), and greenhouse direct-seeded (GHDS) methods was made by Isaacs and Foley (8) in AEC-78, *A Cost Comparison of Conventional and Float Tobacco Transplant Systems*, for a 5-acre conventional plant bed and OP&T system and a 30-acre conventional plant bed and GHDS system. The 5-acre system data are shown in Table 3. The field transplanting was based on a 1-row finger type transplanter with 3 workers (including 1 tractor driver). Notice that the value from AEC-78 used for conventional bed and transplant (CBT) production in Table 3 calculations (15.7 worker-hr/acre) is essentially the same as the Table 1 data of 15.6 worker-hr/acre in the 1990 column, whereas the 5-acre CBT value of 22.4 worker-hr/acre is considerably less than the Table 1 data of 27.3 worker-hr/acre of 1990 (apparently different labor crews evaluated). The OP&T method had −12.3 worker-hr/acre labor reduction, −32% incremental reduction, and −4.0% overall compared with conventional plant beds but an additional production cost of +$0.029/lb per year. Primary advantages producers favored for the OP&T method were the speed and ease of getting large quantities of plants to the field (tray transport) and care for trays of plants in case of inclement weather (place back on water bed or sprinkle on flat surface).

4. Greenhouse Direct-Seeded Trays. Basic plastic-covered Quonset-type or tubular-frame greenhouse structures and gas-fired heating systems were increasingly used by larger growers for transplant production. The greenhouse offered a more work-friendly environment and better control of the temperature and water bed even though disease prevention and management became more of a challenge (see Figure 5). Compared with the OP&T methods, greenhouses had higher capital investment but required less labor for larger-scale operations for plant production. As greenhouse systems and management became more refined and cost competitive, the trend to greenhouse plant production accelerated with many larger producers establishing their own greenhouse production. Subsequently, some greenhouse operators began to sell plants to the majority of producers. Conventional plant beds and the OP&T methods phased out in a few years. However, several growers still use outdoor water beds to grow out plants started in the greenhouse.

A carousel-type transplanter, shown in Figure 6, became the preferred method for transplanting

Table 2. Stripping and marketing comparisons: before and after small bales.

	1972		1990		Change	$/Acre	$/lb per Year
	Labor	Unit	Labor	Unit			
Stripping (4)	130	Worker-hr/acre	75	Worker-hr/acre	−55		
Load out (4)	12.5	"	2	"	−10.5		
Total:	142.5	"	77	"	−65.5	−$262/acre	−$0.105*
On-farm equipment: (9)							
Bale boxes + air compressor			= +$16.85	Per year/acre			
Operating cost			= +$8.75	Per year/acre			
Total:			= +$25.60			Per 2,500 lb/acre	+$0.010
Net change							
Labor:					−65.5		
Savings:							−$0.095

* $282.00/2,500 lb/acre (labor $4/hr, 8,000 plants/acre).
Incremental labor reduction for stripping + load-out = −65.5/142.5 = −0.460 or −46%.
Overall labor reduction for total production = −65.5/309.5 = −0.212 or −21%.

float-bed-produced transplants by most growers because of the substantial reduction in labor requirements that it offered compared with finger-type transplanters. Isaacs and Foley (8) considered a two-row carousel for the 30-acre greenhouse system rather than the conventional 1- or 2-row finger type transplanter of the conventional plant bed and OP&T methods. A 2-row carousel-type transplanter used 2 fewer workers than a comparable 2-row finger type transplanter (1 worker per row plus tractor driver vs. 2 workers per row for the finger type). AEC-78 (8) had greenhouse and transplanter equipment costs included in the plant-production and field-transplanting cost data; thus facility and equipment costs are not listed separately in Table 4. The pertinent plant-production and transplanting data from AEC-78 are summarized in Table 4. Table 4 shows a labor reduction of −17.7 worker-hr/acre, −69% incremental, −5.7% overall, and savings of −$0.086/lb per year for direct-seeded greenhouse transplant production and transplanting using a carousel-type transplanter (3 workers) for 30 acres/year compared with OP&T transplant methods using traditional finger-type transplanter (5 workers) for 5 acres/year.

Figure 3. Tobacco transplant production in conventional outdoor plant beds.

5. Field Curing. Field curing also began to be adopted by producers in the early 1990s. Outside field-curing structures offered a lower-cost facility (approximately 1/5th the investment) and reduced housing labor (approximately 1/3 less) for natural air curing of burley but required diligent covering with plastic and management to keep the plastic secured to protect the tobacco during high wind and rain periods. An example of an outside field-curing structure is shown in Figure 7. Curing was generally equal or superior to barn curing but could be easily damaged by wind and rain if the plastic cover failed to provide protection. The most popular field structure in the early years was the low-cost postrow structure described in ID-116 (5). Comparative labor data from AEN-86, *Moveable Tobacco Curing Frames* (6), shows labor for hauling tobacco approximately 600 ft. from field to similar moveable frames and filling required 17 worker-hr/acre plus 5 worker-hr/acre for covering with plastic, thus a total of 22 worker-hr/acre loading, hauling, and housing with field-curing structures. Data of Table 1 shows 8 worker-hr/acre for typical field load and haul, so a value of 14 worker-hr/acre (22 − 8 = 14) is shown in Table 1 for housing alone

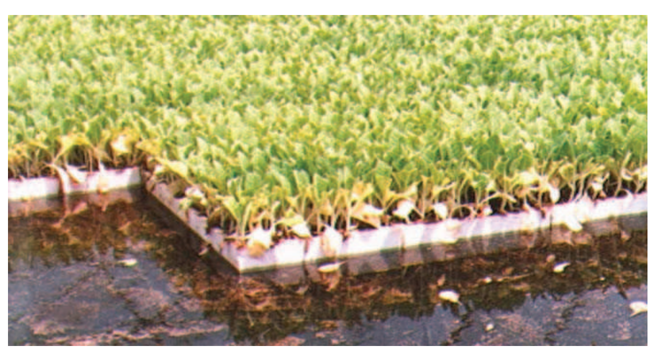

Figure 4. Float trays for tobacco transplant production.

Table 3. Comparisons of 5-acre conventional bed and outdoor-plug-and-transfer (OP&T) transplant methods.

Transplant Production	Worker-hr/Acre	Change	$/Acre	$Change	$/lb per Year
Labor hr					
5-acre conv. bed plant product. (5CBT)	15.7*	-	-	-	
5-acre outdoor plug & transfer (5OP&T)	14.0	−1.7	-	-	
Production costs:					
5-acre conv. bed plant product. (5CBT)			$160.75	-	-
5-acre outdoor plug & transfer (5OP&T)			$291.52	+$130.77	+$0.0523**
Field transplanting					
Labor hr					
5-acre conv. bed transplanting (5CBT)	22.4††	-			
5-acre outdoor plug & transfer (5OP&T)	11.8††	−10.6			
Transplanting costs:					
5-acre conv. bed plant product. (5CBT)			$223.15	-	-
5-acre outdoor plug & transfer (5OP&T)			$164.14	−$58.99	−$0.0236†††
Net change					
Labor:		−12.3			
Cost:					+$0.0287

Data extracted from (8).
* Worker-hr/acre computed from labor costs; labor costs included in production costs below.
** $130.77/2,500 lb/acre (labor $5/hr, 8,000 plants/acre).
†† Worker-hr/acre computed from labor costs; labor costs included in transplanting costs below.
††† $58.99/2,500 lb/acre (labor $5/hr, 8,000 plants/acre).
Incremental 12.3/(15.6 + 22.4) = −0.324 or −32%.
Overall −12.3/309.5 = −0.0397 or −4.0%.

with field-curing structures. The labor requirement for traditional housing from Table 1 was 26 worker-hr/acre, thus a calculated net of −12 worker-hr/acre reduction (34 − 22 = 12) for the filling and covering of field-curing structures. Comparative data are summarized in Table 5. Table 5 shows a benefit of −12 worker-hr/acre, −35% incremental, −3.9% overall, and savings of −$0.11/lb per year (11¢/lb) for typical nearby field-curing structures compared with a conventional 4–5-tier barn. Note: the housing labor data in the next column (#6) reverts back to the previous conventional barn value as field curing did not gain a majority adoption.

6. Stripping Wheel. A stripping innovation that had significant labor savings, relative low cost, and quick payback was the stripping wheel—a circular angle iron ring with metal "pockets" for placing plants to enable workers around the waist-high slowly rotating ring to strip with both hands (see Figure 8). Labor reductions reported by Swetnam et al. (12) using the stripping wheel with 5 or 6 workers—the most efficient crew sizes—and small bales reduced labor by −17.0 and −17.1 worker-hr/acre, respectively, compared with conventional hand-stripping methods in short-time on-farm trials. Commercial prices of stripping wheels ranged from $750 to $900 through the late 1990s. Table 9 shows the amortization costs for a typical stripping-wheel price, life, and other parameters. The

Figure 5. Tobacco transplant production in float trays in a greenhouse.

Figure 6. Carousel transplanter used for transplanting tobacco seedlings produced in float trays.

Table 4. Comparisons of 5-acre outdoor-plug-and-transfer (OP&T) and 30-acre direct-seeded greenhouse.

Transplant Production	Worker-hr/Acre	Change	$/Acre	$Change	$/lb per Year
Labor hr					
5-acre outdoor plug & transfer (OP&T)	14.0*	-			
30-acre direct-seeded greenhouse (GHDS)	3.2*	−10.8			
Production costs:					
5-acre outdoor plug & transfer (OP&T)			$291.52		
30-acre greenhouse direct seeded (GHDS)			$143.88	−$147.64	−$0.0591**
Field transplanting (using carousel transplanter for GHDS)					
Labor hr					
5-acre outdoor plug & transfer (OP&T)	11.8†	-		-	
30-acre greenhouse direct seeded (GHDS)	4.9†	−6.9	-	-	
Transplanting costs:					
5-acre outdoor plug & transfer (OP&T)			$164.14	-	-
30-acre greenhouse direct seeded (GHDS)			$ 97.90	−$66.24	−$0.0265††
Net change					
Labor:		−17.7			
Savings:					−$0.0856

Data extracted from (8).
* Worker-hr/acre computed from labor costs; labor costs included in production costs below.
** $147.64/2,500 lb/acre (labor $5/hr, 8,000 plants/acre).
† Worker-hr/acre computed from labor costs; labor costs included in transplanting costs below.
†† $66.24/2,500 lb/acre (labor $5/hr, 8,000 plants/acre).
Incremental −17.7/(14.0 + 11.8) = −0.686 or −69%.
Overall −17.7/309.5 = −0.0572 or −5.7%.

6- to 8-ft diameter of the stripping wheel plus workers standing around it required a suitable space for its effective operation. The labor savings and amortization costs were the only major impacts of using a stripping wheel. These data are tabulated in Table 6.

Table 6 shows that the stripping wheel reduced labor −17 worker-hr/acre for 5–6-worker crew size stripping, −30% incremental, and −5.5% overall compared with same worker's conventional stripping and using small bales, reducing costs (savings) −$0.053/lb per year. Note the 54.3 and 58.1 worker-hr/acre (mean of 56.2) for the conventional stripping labor rate vs. the 75 worker-hr/acre reported and used in previous stripping summations. Table 1 uses the mean of 39.2 worker-hr/acre ([37.3 + 41.0]/2 = 39.15) for the stripping-wheel labor rate. Labor reduction of similar stalk holding and conveying devices to allow 2-hand stripping should be similar to that of the stripping wheel but capital cost may be significantly different. Note: the stripping labor data revert back to the previous small-bale value without the stripping-wheel benefit as stripping wheels did not gain a majority adoption.

7. Buying Transplants. The buying of transplants rather than the farmer growing them became more prevalent in the mid-1990s as large greenhouse operators could provide transplants competitive with what smaller growers could produce, and some large growers did not choose to operate a greenhouse. The buying of transplants was largely by those giving up on the OP&T

Figure 7. Example of an outside field-curing structure for burley tobacco.

Figure 8. Stripping-wheel tobacco stripping aid.

Table 5. Comparisons of field-curing structures and conventional barns.

	Worker-hr/Acre	Change	$/Year per Acre	$Change	$/lb per Year
Housing labor					
Conventional 4–5-tier barn (load, haul, fill) (4)	34	-		-	
Postrow field structure (load, haul, fill) (5,6)	22	−12		-$96.00	−$0.0384*
Curing structure costs					
Conventional 4–5-tier barn (Table 9)			$425.10		
Postrow field structure (Table 9)			$237.71	-$187.39	−$0.0750**
Net change					
Labor:		−12			
Savings:					−$0.113

* $96.00/2,500 lb/acre (labor $8/hr, 8,000 plants/acre).
** $187.39/2,500 lb/acre.
Incremental −12/34 = −0.353, or −35%.
Overall −12/309.5 = −0.0388 or −3.9%.

Table 6. Comparisons for stripping-wheel stripping data.

	Worker-hr/Acre	Change	$Change/Acre	$/lb per Year
Stripping labor				
Conventional for 5-worker crew	54.3			
Stripping wheel for 5-worker crew	37.3	−17.0		
Conventional for 6-worker crew	58.1			
Stripping wheel for 6-worker crew	41.0	−17.1		
Mean change (mean stripping wheel = (37.3 + 41.0)/2 = 39.2)		−17.05	−$136.40	-$0.0546*
Stripping-wheel costs				
Stripping wheel (Table 9)			+$14.77	+$0.0019
Net change				
Labor:		−17.05		
Savings:				−$0.0527

Data taken from (12).
* $136.40/2,500 lb/acre (labor $8/hr).
Incremental −17.05/([54.3 + 58.1]/2) = −0.303 or −30%.
Overall −17.05/309.5 = −0.055 or −5.5%.

Table 7. Comparative costs for buying transplants and outdoor-plug-and-transfer (OP&T) production.

	Worker-hr/Acre	$/1,000	Change	$/Acre	$Change/Acre	$/lb per Year
Plant production labor						
OP&T, 5 acre (8)	14.0		-		-	-
Buying, transport transplants	2.0		−12		−$60.00	−$0.024*
Plant production costs						
OP&T, 5 acre (8)				$291.52		
Purchase of transplants (8,000/acre)		$40.00		$320.00	+$28.48	+$0.011
Net change						
Labor:			−12			
Savings						−$0.013

* $60/2,500 lb/acre (labor $5/hr, 7,000 plants/acre).
Incremental −12/14 = −0.857 or −86%.
Overall −12/309.5 = −0.0387 or −3.9%.

Figure 9. Big bale of burley tobacco.

or outdoor water beds; thus labor and cost changes are compared with the prior OP&T column. The buying of transplants was judged to cut labor to approximately 2 worker-hr/acre for pickup and hauling for a labor reduction of −12.0 worker-hr/acre. Sale prices of commercially grown plants were around $40/1,000 plants in that era. Thus, 8,000 plants/acre (same as Isaacs and Foley (8) data) cost $320/acre compared with the $291.52 cost of production presented in Tables 3 and 4 for 5-acre OP&T size (8). Greenhouse production costs were $30.22/1,000 as computed by Isaacs & Foley (8). (A cost of interest: Gross et al., (7) calculated and reported that direct-seeded trays germinated and grown in 10-acre outdoor float beds had a cost of $19.07/1,000 plants.) Pertinent buying transplant data are summarized in Table 7. The buying of transplants rather than growing by the OP&T method saved approximately −12 worker-hr/acre, −86% incremental, −3.9% overall compared with the OP&T method, and savings of −$0.013/year per pound.

8. Big Bale Packaging. A 550–650 pound compressed big bale for loose-leaf burley on-farm packaging and marketing was permitted in 2005 after 1 year of experimental testing with burley and several years of similar use in the flue-cured tobacco region. A special welded steel chamber with hydraulic cylinders moving a press-head vertically made a compressed bale of stripped leaves of approximately 40 × 42 × 42 in cube banded with 5 heavy wires. A specially fitted cardboard slip sheet was placed in the bale chamber before filling and provided lower bale protection upon completion (see Figure 9). The heavy bales were moved with forklift equipment or manual pallet jacks. Often a larger stripping space was required to accommodate the stripping, baling, and bale storage needs. Labor savings seemed to occur with larger operations having adequate space and necessary power and equipment. Labor data for comparing small bales and big bales were taken from a multiyear study reported by Bridges et al. (1) on University of Kentucky farm crew stripping operations. Small-bale stripping and packaging data for 8 years averaged 46.3 lb/worker-hr (54.0 worker-hr/acre for a standard yield value of 2,500 lb/acre used in these calculations), considerably less than the previously determined and reported rate of 75 worker-hr/acre, apparently due to experienced workers, economy of scale, and efficient stripping-room and baling setup. Data collected by Duncan (2) for 66,842 lbs (~27 acres) using a big baler with nearly the same 8–9-worker farm crew in 2006 was 58.6 lbs/worker-hr (42.7 worker-hr/acre). Big-bale load-out for transport to market was taken as 0.5 worker-hr/acre from observations of forklift handling of 550- to 650-lb bales onto flatbed trailers. The % incremental labor reduction was taken as the reduction from 56 (54.0 + 2, the 2 being previous small-bale load-out) to 43.2 (42.7 + 0.5) worker-hr/acre.

The amortized cost of a $6,500 big baler used for 25 acres/year and other parameters was $0.0137/lb (Table 9). Purchase of cardboard and wire was valued at that time at $2.25/bale for 550-lb average bale for $0.0041/lb. A $6,000 forklift added $0.0126/lb costs for 25 acres/year and 10-year amortization (Table 9). Further

Table 8. Comparisons of small-bale and big-bale stripping labor and packaging costs.

Method	Worker-hr/Acre	Change	$Change/Acre	$/lb per Year
Small-bale stripping (2)	54.0	-		
Big-bales stripping (1)	42.7	−11.3	− $90.67	−$0.036*
Small-bale load-out (2)	2.0	-		
Big-bale load-out	0.5	−1.5	−$12.00	−$0.005**
Big baler cost (Table 9)				+$0.0137
Cardboard and wire for packaging ($2.25/550 lb)				+$0.0041
Forklift cost (Table 9)				+$0.0126
Net change:				
Labor:		−12.8		
Savings:				−$0.0106 or −$0.011

* $90.67/2,500 lb/acre (labor $8/hr).
** $12/2,500 lb/acre (labor $8/hr).
Incremental −12.8/56 = −0.229 or −23%.
Overall −12.8/309.5 = −0.0414 or −4.1%.

Table 9. Equipment and facility cost analysis for tobacco labor comparisons.

Item	Investment $	Salvage $	Depreciation Year	Depreciation $/Year	Interest $/Year	R,M,I $	Subtotal $	Acres/ Year	$/Acre per Year	$/lb per Year
2-Row carousel[a]	6,500	650	10	585	205	65	855	25	34.19	0.0137
No-till modification.[a]	800	0	10	80	28	8	116	25	4.64	0.0019
Conventional 4–5-tier barn[b]	65,400	0	40	1,635	2,289	327	4,251	10	425.10	0.1700
3–4-tier barn[b]	65,200	0	40	1,630	2,282	326	4,238	10	423.80	0.1695
Economical 2-tier + 1-tier barn[b]	34,000	0	40	850	1,190	170	2,210	10	221.00	0.0884
Postrow field Structure[b]	13,000	0	7	1,857	455	65	2,377	10	237.71	0.0954
Stripping wheel[c]	900	0	10	90	32	100	222	15	14.77	0.0059
Big baler[d]	6,500	650	10	585	205	65	855	25	34.19	0.0137
Forklift (used)[d]	6,000	600	10	540	189	60	789	25	31.56	0.0126

Using straight-line depreciation for useful years (years not Internal Revenue Service compatible); 10% salvage value for equipment or as noted; interest = 7%/year on avg. value of investment minus salvage, repairs, maintenance, insurance (R, M, I) = 0.5% and 1% on investment value of facilities and equipment respectively, except per footnotes, acres/year approximate annual capacity of equipment, standard 2,500 lb/acre yield).

[a] Typical commercial price of 2-row carousel transplanter in 2006; coulter and shank modifications required (10).

[b] Curing-structure construction estimates taken from Duncan (2007b) (3), no salvage value.

[c] Stripping wheel typical commercial price in 2006; small gear-head motor replacement annually taken as $100 repair and maintenance/year (12).

[d] Approximate commercial price of equipment in 2007.

calculations and data are summarized in Table 8. The data for small- and big-bale packaging and handling operations from several years of University of Kentucky data show a reduction for big bales of −12.8 worker-hr/acre, −23% incremental, −4.1% overall, and slight savings of −$0.011/lb per year (a little over 1¢/lb per year) of tobacco for a system having a new investment of over $11,000 plus adequate stripping room or barn space for big-baler operations. The combination and impact of stripping aids and big-bale packaging has not been fully documented and reported as of this writing.

SUMMARY

Major labor-reducing developments in burley production practices for the 1972–2007 era were analyzed for reductions in labor requirements and the economic effects those reductions had for burley producers. Major mechanization developments of the era considered in the analysis include the adoption of small-bale packaging, the transition from plant beds to float-bed systems, the use of outside field-curing structures, the use of stripping wheels and similar stripping aids, and the adoption of big-bale packaging. Total labor requirements at the beginning of the era were reported at more than 300 worker-hr/acre, but were reduced a total of 157 worker-hr/acre by 2007, or more than 50%, considering the methods that were widely adopted. Most of the adopted practices resulted in net savings to the producer at the time considering both labor savings and additional investment requirements. The associated cost reductions cannot be accurately summed from the data due to repeated use of some components among the multiple methods and the ever-changing materials and labor costs over 3 decades. The data presented are for conditions described and year noted.

Many variations exist for producers that can limit effective adoption and utilization of these advancements such as excessive travel and transport of equipment, personnel, supplies, and the crop among multiple farms, varying labor supply, equipment availability, and marketing distances. The practices reported are a goal for any producer to seek to remain efficient and profitable in burley production. Options for potential further labor reduction and cost benefits will be analyzed in the second article in this series, *Reduction in Labor Requirements for Burley Tobacco Production, Part 2: Potential.*

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