FLUE-CURED TOBACCO
MECHANIZATION AND LABOR:

Impacts of Alternative Production Levels

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ABSTRACT

The flue-cured tobacco industry is in a state of transition as farmers are replacing the traditional harvest methods with modern bulk curing systems. The rapid trend toward harvest mechanization experienced in 1972-75 will continue into the eighties, according to an analysis of a wide range of quota levels and wage rates. Adopting new harvest technology is profitable for farmers, and it will have an impact on the demand for harvest labor.

In the aggregate, however, harvest mechanization will not cause serious unemployment problems in the flue-cured tobacco belt. During 1972-80, with increased wage rates, the decline in the number of harvest workers is projected to range from 64,000 workers, under a "high" level of production, to 199,000, under a "low" level of production.

Harvest jobs are part-time and seasonal. Workers most likely to lose harvest job opportunities are young persons and women. Of tasks eliminated with bulk curing systems, more than 90 percent in 1972 were performed by young persons (mainly 12 to 15 years of age) and by women.

KEYWORDS: Farm operators, flue-cured tobacco, harvesting, labor, mechanization.

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Related Economic Research Service reports include *Dynamics of the U.S. Tobacco Economy*, Technical Bulletin No. 1499, and *Structural Characteristics of Flue-cured Tobacco Farms and Prospects for Mechanization*, Agricultural Economic Report No. 277.

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*All tables in this report are based on flue-cured tobacco farms in the study area during 1972, unless otherwise noted.

SUMMARY

The flue-cured tobacco industry is in a state of transition as farmers are replacing traditional harvest methods with modern bulk curing systems. In 1972, only 1 percent of the flue-cured tobacco crop was harvested mechanically, and 8 percent was cured in bulk barns. By the 1975 crop harvest, an estimated 38 percent was cured in bulk barns, and 18 percent was mechanically harvested.

Analysis of a wide range of quota levels and wage rates shows that the rapid trend toward harvest mechanization experienced in 1972-75 will continue into the eighties. The analysis is based on the assumption that farmers will choose to adopt, subject to various constraints, the optimal mix of harvest technology which maximizes the return to unpaid labor, allotment, land, and management.

In general, flue-cured tobacco farmers did not use the most profitable harvest systems in 1972. They used about 72.2 million hours of labor (187 hours per acre) in the study area to harvest the 1972 crop. Adoption of optimum systems throughout the study area in 1972 could have reduced the total use of harvest labor to about 47 million hours.

By 1980, it is expected that 65 to 92 percent of the flue-cured tobacco crop will be bulk cured, and 17 to 30 percent will be harvested mechanically. In fact, mechanical harvesters were already being used to prime more than 17 percent of the 1975 crop. The future size distribution of flue-cured tobacco farms, amount of harvest mechanization, and consequent effects on harvest labor will depend importantly on the size of tobacco quotas and wage rates. In the study area, the most significant decline in production units, about 37% is projected for the "low" quota alternative (a quota of 50 percent less than for the 1972 production). Moreover, production shifts sharply to smaller units with this alternative.

It does not appear that harvest mechanization will cause serious unemployment problems in the flue-cured tobacco belt—even at high wage rates. During the 1972-80 period, with increased wage rates, the decline of harvest workers is projected to range from 64,000 (with a "high" level of production) to a maximum of 199,000 workers (with a "low" level). However, for the "low" quota situation, about 70,000 of the workers are displaced because of the need for fewer workers to produce a smaller crop.

Geographically, the potential displacement of harvest workers appears greatest in the Coastal Plain, which is the most concentrated area of flue-cured tobacco production. The average annual reduction in the 14 counties studied in the Coastal Plain is projected to range from 240 to 770 workers per county. The lowest displacement of harvest workers will occur in the Pee Dee-Lumber River, Piedmont, and Georgia areas because of less concentrated tobacco production. With a "low" quota situation, the projected number of harvest workers needed by 1980 ranges from 53,000 fewer in the Piedmont area (300 per county per year) to 20,000 fewer in Georgia (130 per county per year). With the "high" quota situation, displacement of workers is estimated to range from 19,600 in the Pee Dee-Lumber River area (223 per county per year) to 3,500 in Georgia (23 per county per year).

Since harvest jobs are part-time and seasonal, their loss is less crucial than the loss of a year-round job. Many harvest workers who may lose such job opportunities are young persons who tend to 'graduate' from this transitory employment. Of the tasks eliminated with bulk curing systems, more than 90 percent in 1972 were performed by young persons (mainly 12 to 15 years of age) and women. But, individuals greatly dependent on harvest earnings, and with no other job opportunities, can ill afford to lose harvest employment. So, some families providing harvest workers may be more seriously affected than is apparent from the projections.

FLUE-CURED TOBACCO MECHANIZATION AND LABOR: Impacts Of Alternative Production Levels

By Frederic L. Hoff,
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INTRODUCTION

Historically, labor has been a major input in the production of flue-cured tobacco. Only in the last decade has substantial progress been made in mechanizing traditional production techniques. Development of bulk barns and automatic harvesters has now created the potential to transform flue-cured tobacco production from a labor intensive to a capital intensive operation. Still, a majority of the tobacco farmers have not yet made this shift.

Within the last 5 years various technological, institutional, and economic forces have exerted a strong influence to change traditional flue-cured tobacco production techniques. Strong demand for flue-cured tobacco and market acceptance of tangled leaves have made machine harvest feasible. With sharp increases in production costs, tradition has given way to pragmatic economic considerations. Farm wage rates have reached levels that make cost comparisons favorable for harvest mechanization. Lease and transfer provisions of the tobacco program ease some of the problems associated with organizing economic size units in the environment of fragmented allotment control. Many of these forces are expected to continue and labor reducing technology will be increasingly adopted on flue-cured tobacco farms in the seventies.

Flue-cured tobacco harvest mechanization will impact on farmers, hired workers, and communities in the tobacco growing regions. It can lead to greater production efficiency for farmers, but some tobacco workers may be deprived of harvest employment. How much mechanization will be adopted? How fast will adoption occur? Will job opportunities lost because of harvest mechanization cause serious unemployment problems for tobacco growing regions? These are the issues addressed in this study.

OBJECTIVES AND PROCEDURE

This study extends an earlier analysis by ERS which evaluated mechanization prospects under the assumption that future flue-cured tobacco production would continue at the 1972 level. With this assumption it was estimated that by 1978 as much as 36 percent of the U.S. flue-cured tobacco would be harvested mechanically and up to 80 percent cured in bulk barns (*2*).[2]

However, flue-cured tobacco quotas were annually increased after 1972—the basic quota for 1975 was 46 percent above 1972 production. Although demand for flue-cured tobacco showed considerable strength early in the seventies, there remains some uncertainty of future demand and hence future production quotas. The major objectives of this study are to analyze the prospects for tobacco harvest mechanization at alternative production levels and to evaluate effects of resulting adjustments on the farm labor force and structure of flue-cured tobacco farming.

To accomplish this objective, linear programing models were formulated which measured the relative profitability of various harvest systems and monitored the effects of shifts in farm size, enterprise mix, and resource utilization for different production levels and wage rates. The models incorporated the cost relationship of harvest technology to farm size, government program controls, and resource supply constraints.

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[1]The authors are agricultural economists in the Commodity Economics Division of the Economic Research Service, U.S. Department of Agriculture.

[2]Italicized numbers in parentheses relate to references listed at the end of this report.

Data Sources

Data requirements of this analysis were such that little could be derived from secondary sources. Information on organization, resources, and technology of flue-cured tobacco management units was essential. Thus, a survey of farms in four agricultural regions (which contain about three-fourths of the flue-cured tobacco production in the United States) was conducted in 1972 (fig. 1).[3]

Questionnaires were completed for 1,083 tobacco farm operators.[4] Detailed information was collected on land use, crop and livestock production, machinery and equipment, tenure arrangements, tobacco curing facilities and harvest systems, labor use, characteristics of family members and hired workers, off-farm employment, and income. Supplemental information was obtained from sharecroppers and combined with data for appropriate management units. These data were the basis for the analytical models depicting decisionmaking units.

Method of Analysis

Mechanization of cultural practices has proceeded slowly for flue-cured tobacco. Not until late in the forties and early in the fifties did various technological, institutional, and economic forces exert a strong influence on traditional methods of producing flue-cured tobacco.

[3]All figures and tables in this report are based on flue-cured tobacco farms in the study area for 1972, unless otherwise noted.

[4]In this report the term "farm" is synonymous with management unit and operator unit. This definition of a farm is not consistent with the one specified in the census. For census purposes, sharecroppers are included in the farm population as separate units. In this study, all land farmed by sharecroppers is included with the operator's acreage and classified as a single managementt unit. This procedure provides for fewer farms in the study areas than does the census definition.

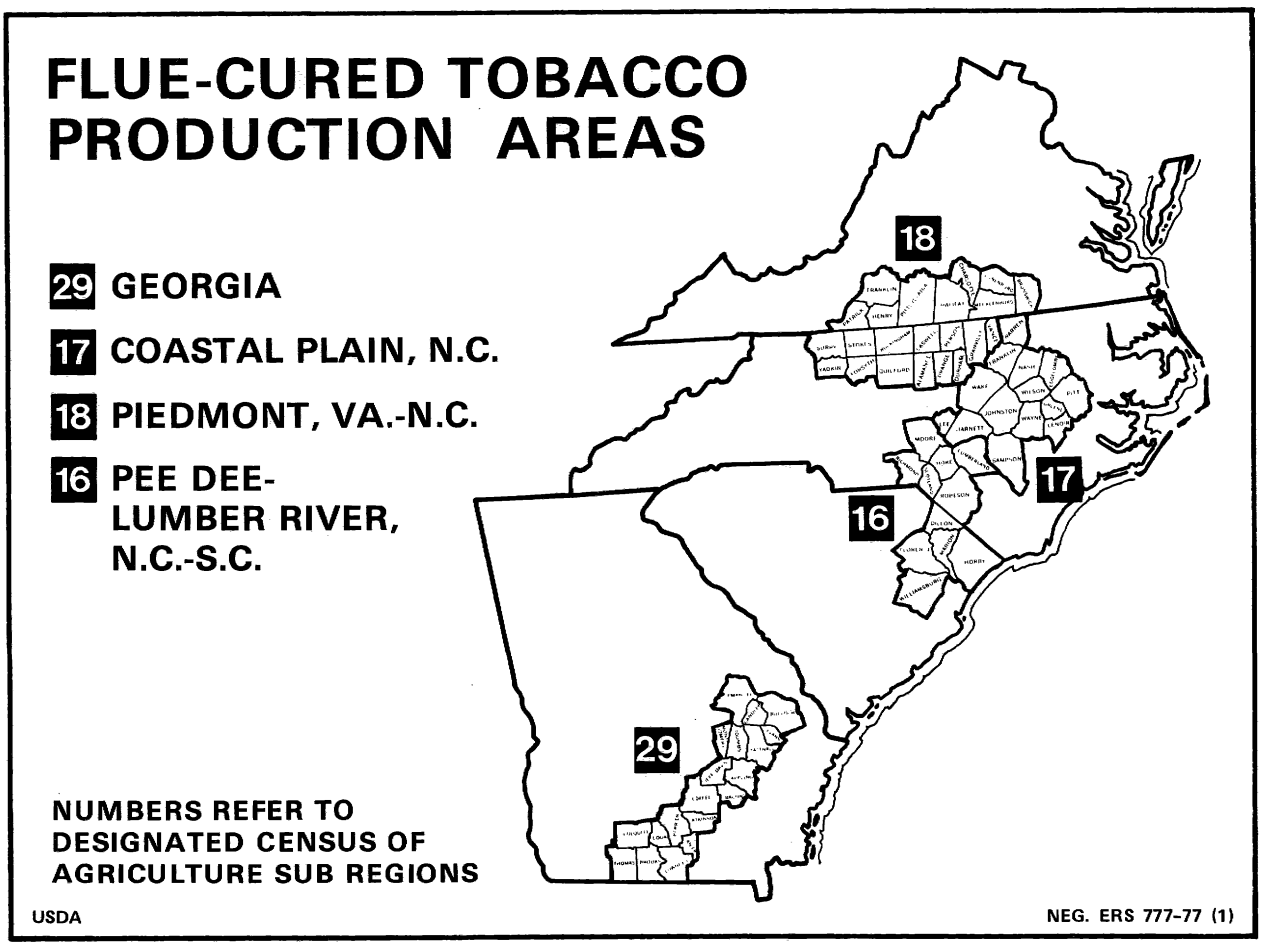

FIGURE 1

Today, harvest techniques in use on flue-cured tobacco farms range from the oldest traditional, labor intensive (walking primer-hand loop-conventional curing) methods to highly mechanized, capital intensive (mechanical harvester-bulk curing) operations. The choice of profitable tobacco harvest systems depends on several factors. The quantity of tobacco grown on a management unit is important. Furthermore, the choice varies by geographic area because of regional differences in farm wage rates and in the availability of tobacco workers. Other factors include the cost of capital investments, topography, tradition, and expectations about the future of tobacco production. In general, the laborsaving systems become more profitable as the size of the management unit increases.

Representative Resource Situations

A regional model was developed for each of the four production areas to account for differences in farm wage rates, supply of tobacco harvest workers, and topography. Each regional model was further stratified into six size groups to represent the range in quantity of tobacco grown among management units.

The regional and size groupings (by acres of tobacco grown in 1972) are shown in table 1.[5] Each size group is represented by a pooled resource situation possessing the characteristics of all the units in the group at the time of the survey. The six size groups interact through the lease and transfer of tobacco allotments.

Linear Programing Technique

A "polystructural" linear programing model was developed for each of the four production areas to analyze the adjustment of flue-cured tobacco growers to technological changes, increased farm and nonfarm wage rates, and variations in tobacco production.[6] Coefficients for each geographical area were derived from the 1972 survey. The objective criterion of each regional model was the simultaneous profit maximization of the six size groups subject to restrictions on enterprise levels and resource supply. Profit was measured as the net return to unpaid labor, land, allotment, and management.

Basic Assumptions.—Certain simplifying assumptions were needed to reduce the problems of data compilation and computer computation to a manageable size. These assumptions permitted the construction of program models that were sufficiently comprehensive and detailed to simulate realistically the farm and nonfarm activities of the management units studied.

The basic assumptions of the analysis were:

1. Specific characteristics of the flue-cured tobacco farms studied can be represented by four spatially separated and independent producing regions, each of which is stratified into six tobacco acreage size groups that are internally homogeneous.

2. Land is a homogeneous factor within each representative size group and competed for by all crops produced in each group.

3. Cropland, pasture, and allotments for tobacco, peanuts, and cotton are limiting factors of production in each representative size group. Other resources, including capital, are in adequate supply and do not restrict production.

4. Farmers are restricted to produce the same agricultural products as reported in the 1972 survey. The level of production can be adjusted to use available resource inputs.

[5]Only flue-cured tobacco farms were analyzed in this eport, although figure and table headings do not always nake the designation.

[6]"Polystructural" indicates that the algorithm simultaneously determines the profit-maximizing level of economic activity for several structurally different groups of management units.

Table 1.—Size distribution of farms by area

Operation ize by acres of tobacco grown[1]	Pee Dee-Lumber River N.C.-S.C. 16		Coastal Plain N.C. 17		Piedmont N.C.-Va. 18		Georgia Ga. 29		All areas	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*	*Number*	*Percent*
is than 3 . . .	1,514	22.4	1,939	14.3	3,586	22.5	701	16.4	7,740	19.1
.99	2,567	38.0	4,959	36.4	7,814	48.9	1,969	46.3	17,309	42.6
4.99	1,181	17.5	3,291	24.3	2,454	15.4	968	22.7	7,894	19.5
19.99	411	6.1	1,623	12.0	1,170	7.3	300	7.1	3,504	8.6
34.9	668	9.9	1,398	10.3	754	4.7	284	6.7	3,104	7.7
or more . . .	411	6.1	361	2.7	189	1.2	33	.8	994	2.5
otal	6,752	100.0	13,571	100.0	15,967	100.0	4,255	100.0	40,545	100.0

From a 1972 survey by Economic Research Service and Statistical Reporting Service.

5. All farmers within a region and size group who produce a specific product or use the same tobacco harvest systems have identical input-output coefficients. However, these coefficients vary among the same systems and enterprises in different size groups and production regions.

6. Farmers maximize profits (net returns to unpaid labor, land, allotment, and management) in choosing among the farm and nonfarm activities under consideration.

In addition to those above, the usual assumptions of linear programing apply (*4*).

Model Constraints and Program Alternatives.—To measure the effect of alternative wage rates and levels of tobacco production, optimal solutions were analyzed for different combinations of constraints. An initial LP solution (actual) simulated farm and nonfarm activities, production levels, allotments, and wage rates reported in the survey, and it was used as a base to measure the impact of changes in the economic and institutional variables. Next, linear programing solutions (optimal) were computed for each study area (using 1972 quota and wage rates) to determine whether flue-cured tobacco farmers were using the optimal mix of harvest systems in 1972.

Analyses of conditions projected by 1980 were made for "low," "medium," and "high" quota levels and increased farm and nonfarm wage rates under a program of lease-and-transfer. The "medium" quota situation represented 1972 production, and the "low" and "high" quota situations corresponded to a 50-percent decrease and increase, respectively, in 1972 production. Besides being evaluated at 1972 levels, farm and nonfarm wage rates (relative to other costs) were increased 50 percent and 40 percent, respectively.

Tobacco activities.—The flue-cured tobacco enterprise was considered in detail in the programing models. A maximum of ten different tobacco budgets were constructed for each of the six size groups to represent the major systems used in 1972 to harvest and cure flue-cured tobacco. These harvest systems are identified in this report through use of a 3-digit code.[7] The first digit refers to method of removing leaves from the tobacco stalk, the second to the method of preparing leaves for curing, and the third to the type of curing barn (table 2).

Equipment and facilities.—Decisions of tobacco growers to adopt more capital intensive harvesting-curing systems usually result in the purchase of additional equipment, the construction of new facilities, or both. In this analysis the choice of harvest systems was based on a comparison of costs and returns for the various systems available. This comparison ignores the "sunk" costs for equipment and machinery used in 1972.

Tying machines, priming aids, mechanical harvesters, conventional barns, and bulk barns were the five items of equipment and facilities considered. Each item was assumed to have the following maximum capacity:

Item	*Capacity/unit* (year)
Tying machine	20 acres
Priming aid	35 acres
Mechanical harvester	60 acres
Conventional barn	2.25 pounds per cubic foot
Bulk barn	108 pounds of cured leaf per rack

The total existing capacities of these items were computed for each representative size group by multiplying the maximum capacity of each item by the number of units inventoried in the 1972 survey. Additional capacity was available through purchase activities.

New tobacco harvest equipment, such as 2-row and tractor-mounted harvesters, once-over harvesters, and large curing containers, has been placed on the market since the 1972 survey. Since production coefficients for these new items of machinery are not available, they are not analyzed in this study. So, results of this study would be modified to the extent that these new harvest systems offer different labor savings and adoption potentials to farmers.

Labor.—Five types of laborers were considered in each size group: family, regular (full-time) hired, seasonal (part-time) hired, exchange, and sharecropper. The total available supply of each type labor was specified by the calendar year quarters: January-March, April-June, July-September, and October-December. Seasonal labor was further categorized by

[7]For more detail about the various harvest systems, see Agricultural Economic Report 277 (*2*).

Table 2.—Combinations of harvesting methods, curing preparation techniques, and curing methods that were selected for analysis

Harvesting	Curing preparation	Curing method
(1) Walking primers	(1) Tie on sticks by hand at barn	(1) Conventional barn
	(2) Tie on sticks by hand in field	
(2) Riding primers	(3) Tie on sticks by machine at barn	
	(4) Tie on sticks by machine in field	
(3) Mechanical harvester	(5) Bulk rack at barn	(2) Bulk barn
	(6) Bulk rack in field	

age of worker (less than 18, 18 to 45, and more than 45 years). A summary of harvest labor provided by different worker types is in the appendix tables.

Wage rates received by tobacco workers varied by task, tobacco acreage size group, and region. Larger farms paid slightly higher wages because they competed more with off-farm employers and some were covered by the Fair Labor Standards Act. Wage rates varied by task because of different skill and physical stamina requirements. Regional variations in farm wage rates appeared to be related to the availability of off-farm employment.

Wage rates received for all harvest tasks were averaged for seasonal and regular hired workers by size of farm and region. These wage rates were used for the labor hire activities. Exchange labor was obtained at no wage cost. But for each hour of exchange labor used, 1 hour of family labor was required to compensate the exchange workers.

Lease and transfer provisions.—The lease and transfer program for flue-cured tobacco began in 1962. It provided for lease of quota separate from the land. This gave growers more flexibility in aggregating larger production units since leased quota did not have to be produced on the land of the quota owner. However, leasing is restricted by the provision that the total tobacco allotment allowed on a farm cannot exceed half of the cropland on that farm after the transfer of allotment.

A set of activities included in the models permitted the movement of tobacco allotment among the six representative tobacco acreage size groups in each study region. These transfer activities were designed to simulate, as nearly as possible, how farmers decide to lease-in or lease-out tobacco quota.

A common lease rate of 22 cents per pound was used in each region for the transfer activities. Lease rates are known to vary widely among counties and from one flue-cured tobacco production belt to another (*6*). However, the model was not designed to provide county solutions. Use of the single lease rate implies that quota is free to move across county lines within each region. This tends to overstate the amount of quota consolidation because such movement is not permitted under the tobacco program conditions of this analysis. However, the amount of possible overstatement of quota consolidation is minimized because lease rate differences among counties within the selected production regions are minimal.[8]

Economically, a tobacco farmer would lease-out allotment whenever the inputs used to produce tobacco could be reallocated to other farm and nonfarm activities and earn an income that exceeds the income from tobacco. For some farmers, the income from leasing-out alone may exceed tobacco income. For others, income may be increased by expanding tobacco acreage and mechanizing present harvesting-curing systems. Within the models, tobacco allotment was permitted to be leased-in or leased-out of the farms in a particular size group only when farms in another group or groups could economically justify leasing-out or leasing-in allotment.

Tobacco allotment transfer activities in the programing matrix provided three tobacco production alternatives. These options were available to farms in each representative allotment size group.

Alternative 1 permitted operators to lease-in tobacco allotment at 22 cents per pound. With the additional allotment, these farms could acquire new production functions which reflected more mechanized harvest methods and economies of size that reduced unit costs.

Alternative 2 permitted operators to lease-out tobacco allotment at 22 cents per pound. However, this alternative was restricted, so tobacco was leased-out only when the combination of income from the lease and income earned by reallocating the tobacco inputs to other alternatives exceeded income from producing flue-cured tobacco. It also assumed that released family labor could be employed in nonfarm jobs at prevailing wage rates.

Alternative 3 permitted tobacco operators to maintain their 1972 level of tobacco production. They neither leased-out nor leased-in tobacco quotas, but they could adopt new harvest technology.

Enterprise alternatives.—Budgets were estimated for all major crop and livestock enterprises produced in 1972 on farms in each representative size group. Input and commodity prices and yields were based on average levels for 1972 in the study area. The production level of each specified enterprise was obtained from the survey. Technology reflected 1972 practices and techniques.

Nonfarm employment.—Two nonfarm employment activities were available for family household members. The first consisted of quarterly employment of household members constrained to levels reported in the 1972 survey. The second permitted employment of family labor displaced from tobacco production and constrained by job levels predicted to exist by 1980. The nonfarm wage rates were the average for occupations reported.

Capital.—Capital was assumed to be available in sufficient quantities so as not to constrain harvest mechanization. However, an interest charge was included in all crop and livestock budgets to reflect the costs of operating and fixed capital.

Resource and institutional constraints.—The model contained four categories of quantitatively stated constraints: land, production and quota, equipment and facilities, and labor. The assumptions regarding equipment and labor have already been stated.

[8]For an estimation of average rental rates per pound for flue-cured tobacco, see Hoover, Dale M., "Lease and Transfer of Flue-cured Tobacco Marketing Quota Among Farms," EIR-6, North Carolina State University, Raleigh, Dec. 1967, pp. 9-14.

Two categories of land constraints were used to limit farm production. Cropland consisted of the acreage available or potentially available for crop production. Cropland pasture could be used for crops or livestock grazing. Pastureland was the acreage available only for livestock grazing. The regulation of crop production by allotments or quotas constrained the acreage of peanuts, cotton, and tobacco.

TOBACCO HARVEST AND CURING TECHNIQUES

Total labor use (plant bed, preharvest, harvest, market) in the flue-cured tobacco belt decreased from 236 million hours in 1965 to 141 million hours in 1972. This is a 40-percent decline (2).

Variations in Harvest Technology

Methods of harvesting and curing the 1972 flue-cured tobacco crop differed among the four regions and six size groups studied. In Georgia nearly a fifth of the tobacco crop was cured in bulk barns (table 3). Additionally, riding primers harvested more than 85 percent of the tobacco. Tobacco producers in the Piedmont used walking primers to harvest 90 percent of their crop, but 70 percent used tying machines to prepare leaves for curing. Several harvest systems were used in the Pee Dee-Lumber River and Coastal Plains. About 40 percent of the growers used automatic tying machines in each region, and a third used priming aids. About 1 percent of the 1972 U.S. flue-cured tobacco crop was harvested with mechanical tobacco harvesters.

In 1972, capital intensive harvest systems were used most by the larger tobacco farmers. Almost 45 percent of the farmers with 35 acres or more reported using priming aids, and nearly a fourth used tying machines or bulk barns. In contrast, the small farmers (particularly those producing less than 3 acres of tobacco) used only conventional barns to cure their crop. Almost two-thirds of them still used the traditional hand priming and looping harvest methods. Many farmers with 3 to 9 acres of tobacco used tying machines to attach the leaves to sticks. These reliable machines provide labor savings at a low investment cost.

Technology and Reduced Labor Use

Adoption of tying machines, priming aids, bulk barns, and mechanical harvesters to aid in the harvest and curing of flue-cured tobacco has substantially reduced the use of harvest labor. In 1972, the 111 system (walking primers, hand loopers at barn, conventional curing barn) was the most labor intensive. Total labor use for all phases of production with this system averaged 18.6 hours per 100 pounds of tobacco in the study area (table 4). Least labor intensive (excluding the mechanical harvester) was the 262 system (riding primers, bulk racking in the

Table 3.—Percentage of tobacco crops harvested by various systems[1]

Harvest system	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
	Percent of pounds				
Conventional curing barns:					
111 (walking primers-hand loopers)	17.5	21.6	18.0	7.8	18.4
131 (walking primers-tying machine)	28.6	31.6	70.5	1.0	38.7
211 (riding primers-barn hand loopers)	.7	3.9	---	1.3	1.9
221 (riding primers-riding hand loopers)	31.3	24.2	.7	68.5	23.6
231 (riding primers-tying machine)	12.3	12.8	5.8	2.0	9.6
Total	90.4	94.1	95.0	80.6	92.2
Bulk curing barns:					
152 (walking primers-rack at barn)	5.7	1.3	1.5	3.0	2.4
162 (walking primers-rack in field)	.5	1.2	---	3.0	.9
252 (riding primers-rack at barn)	--	.1	1.8	.9	.6
262 (riding primers-rack in field)	3.4	3.3	1.7	12.5	3.9
Total	9.6	5.9	5.0	19.4	7.8

[1] Dashes mean that no operators surveyed reported using the designated system in 1972. Codes refer to harvest systems defined in table 2.

field, bulk curing barns). Total labor use with the 262 system averaged 9 hours per 100 pounds.

A variety of operations are included in the harvest phase of flue-cured tobacco production. As shown in table 5, total harvest labor (priming, curing, market preparation) ranged from 12.9 hours per 100 pounds for the 111 harvest system to only 2.8 hours for the mechanical harvester (352) system.[9]

[9]Manufacturers of mechanical harvesters report that some farmers have reduced harvest labor requirements to less than 2.8 hours per 100 pounds of tobacco.

Table 4.—Labor used per hundredweight for production and harvesting by harvest system in each study area[1]

Harvest system	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
	Hours per 100 pounds				
Conventional curing barns:					
111 (walking primers-hand loopers)	19.3	16.9	18.0	21.0	18.6
131 (walking primers-tying machine)	13.5	13.3	14.3	20.4	14.3
211 (riding primers-barn hand loopers)	18.6	16.6	---	16.9	17.3
221 (riding primers-riding hand loopers)	13.1	13.8	13.7	14.3	13.7
231 (riding primers-tying machine)	14.0	13.2	13.2	14.3	13.6
Bulk curing barns:					
152 (walking primers-rack at barn)	10.0	11.6	10.9	11.2	10.7
162 (walking primers-rack in field)	11.4	8.8	---	9.3	9.5
252 (riding primers-rack at barn)	--	11.6	11.0	12.1	11.6
262 (riding primers-rack in field)	8.8	8.4	8.2	9.5	9.0

[1] Harvest includes market preparation labor. Dashes mean that no operators surveyed reported using the designated system in 1972. Codes refer to harvest systems defined in table 2.

Table 5.—Harvest labor used per acre and per hundredweight by harvest system[1]

Job[2]	Harvest system[3]									
	Conventional curing barn					Bulk curing barn				
	111	131	211	221	231	152	162	252	262	352[4]
	Hours per acre									
Walking primer	56.80	49.97	---	---	---	47.33	32.09	---	---	---
Riding primer	---	---	54.65	44.95	45.75	---	---	40.23	33.19	---
Hander	58.97	---	53.37	---	---	---	---	---	---	---
Hand looper	30.66	---	34.79	45.11	---	---	---	---	---	---
Bulk racker	---	---	---	---	---	25.73	13.05	36.79	22.65	12.00
Tractor driver	16.54	12.64	20.51	12.21	15.91	11.59	13.37	9.78	9.76	6.00
Priming-aid driver	---	---	3.98	5.12	3.41	---	---	1.60	1.62	---
Mechanical harvester driver	---	---	---	---	---	---	---	---	---	6.00
Tying machine worker	---	37.04	---	---	41.26	---	---	---	---	---
Shaker	---	6.75	---	---	8.42	---	---	---	---	---
Hang tobacco in conventional barn	18.96	15.51	24.80	25.28	19.97	---	---	---	---	---
Fill bulk barn	---	---	---	---	---	20.97	13.73	23.98	10.42	12.00
Take tobacco out of barn	13.48	12.62	16.57	13.55	14.01	13.18	9.78	11.99	7.29	8.00
Prepare tobacco for market	35.77	29.64	39.70	41.50	33.11	13.05	11.92	11.82	13.55	12.58
Other[5]	5.08	1.75	10.25	10.24	4.60	2.08	1.51	---	2.81	2.13
	Hours									
Total harvest labor:										
Per acre	236.26	165.92	258.62	197.96	186.44	133.93	95.45	136.19	101.29	58.71
Per 100 pounds	12.87	8.95	12.70	9.30	9.00	6.15	4.80	6.91	4.48	2.79

[1] Harvest labor is defined as the labor used for all harvest tasks beginning with priming of leaves up to and including market preparation. [2] All harvest tasks are not required for each harvest system. [3] Refers to harvest system codes defined in table 2. Dashes mean that the harvest system does not employ the particular job. [4] Labor use for the mechanical harvest system was developed from published research and engineering data. [5] Includes all jobs not easily categorized.

Table 6.—Total labor used per area for harvesting by harvest job[1]

Job	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
	1,000 hours				
Walking primer	2,281.5	4,834.4	5,218.6	351.9	12,686.4
Riding primer	1,397.9	3,065.8	414.9	1,407.7	6,286.3
Hander	1,013.8	2,428.7	1,202.5	260.3	4,905.3
Hand looper	1,436.8	2,964.0	657.5	1,311.8	6,370.1
Bulk racker	146.8	185.4	136.7	168.9	637.8
Tractor driver	1,029.9	2,249.0	1,495.3	493.5	5,267.7
Priming-aid driver	137.8	288.5	28.4	146.2	600.9
Tying machine worker	1,205.4	2,802.2	3,195.7	59.0	7,262.3
Shaker	227.3	532.1	587.9	11.5	1,358.8
Hang tobacco in conventional barn	1,365.8	2,977.4	1,758.4	771.6	6,873.2
Fill bulk barn	104.2	117.7	89.1	99.3	410.3
Take tobacco out of barn	984.6	2,111.3	1,425.0	499.9	5,020.8
Prepare tobacco for market	2,500.0	5,400.2	3,375.7	1,386.1	12,662.0
Other[2]	390.2	834.5	283.1	313.9	1,821.7
Total harvest labor	14,222.0	30,791.2	19,868.8	7,281.6	72,163.6

[1] Harvest labor is defined as the labor used for all harvest tasks beginning with priming of leaves up to and including market preparation. [2] Includes all jobs not easily categorized.

About 72.2 million hours of labor were used in the survey area to harvest the 1972 tobacco crop (table 6). This was nearly 9.6 hours of labor per 100 pounds of tobacco or 187 hours of labor per acre (1,950 pound yield). Tobacco priming accounted for about 18.9 million hours or a fourth of the harvest labor. If all tobacco in the four regions had been harvested by the traditional 111 harvest system, nearly 97 million hours of labor would have been needed. This indicates that the technology used in 1972 reduced harvest labor needs by about a fourth.

To provide perspective for evaluating linear programing projections of harvest mechanization through 1980, actual levels of mechanization in 1972 were compared with optimal solutions for 1972 conditions. A flue-cured tobacco harvest system is defined as optimal when net returns to unpaid labor, land, allotment, and management are maximized.

Table 7.—Percentage of tobacco harvested with actual and optimal harvest systems

Harvest system[1]	Actual	Optimal
	Percent of pounds	
Bulk curing barns:	7.8	62.8
Hand harvest (152,162)	3.3	29.5
Riding primer (252,262)	4.5	16.3
Mechanical harvester (352)	([2])	17.0
Conventional curing barns:	92.2	37.2
Hand harvest (111)	18.4	2.3
Riding primer (211,221)	25.5	13.3
Tying machine (131)	38.7	20.4
Riding primer and tying machine (231)	9.6	1.2

[1] Codes refer to harvest systems described in table 2. [2] No mechanical harvester systems appeared in the survey. However, information from other sources indicates that it was used in 1972 on less than 1 percent of the farms to harvest about 1 percent of the acreage.

Optimal Harvest Technology

Based on cost estimates developed for the linear programing models, farmers in general did not use the optimal mix of harvest systems in 1972. Linear programing solutions show that the most profitable systems under 1972 conditions include bulk curing 63 percent of the crop and mechanical priming 17 percent (table 7). This is a significantly higher level of bulk curing than the 8 percent reported in 1972. Mechanical harvester systems were the most profitable only on the larger units.

In 1972, tobacco growers with less than 3 acres of tobacco could not profitably adopt much new harvest technology (table 8). On smaller farms the 111 (walking primers-hand loopers) and 221 (riding primers-riding hand loopers) harvest systems were optimal. For many tobacco farmers with 3 to 15 acres of tobacco, the 131 (walking primers-tying machine) system was optimal. On intermediate and larger size farms, bulk barns and other means of partial mechanization were most profitable. The optimal mixes of harvest systems by size group and region are shown in table 9.

Adopting the optimum systems throughout the study area in 1972 (without additional lease-and-transfer than reported on the 1972 survey) could have reduced the total use of harvest labor from 72.2 to 46.9 million hours (table 10). This shift entails a reduction in labor needed for all tasks, except for bulk rackers and bulk barn fillers. Using bulk barns eliminates several jobs, such as handers, hand loopers, tying machine workers, and shakers.

Farmers using equipment and facilities which have additional useful life are often reluctant to invest in laborsaving capital. Some of these farmers may be optimizing shortrun returns, but others may not be certain about production costs for different harvest systems. These are probably two major causes for the gap between actual and optimal harvest labor use in 1972. However, confronted with rising wage rates, tobacco operators are narrowing this gap as cost advantages of laborsaving systems have become evident.

Table 8.—Percentage of tobacco harvested with actual and optimal harvest systems by group and operation size

Group and operation size by acres of tobacco grown	Actual	Optimal
	Percent of pounds	
Bulk curing barns:	7.8	62.8
Less than 3	0	0
3 - 8.99	.5	2.9
9 - 14.99	.9	13.5
15 - 19.99	.8	13.1
20 - 34.99	3.4	19.9
35 or more	2.2	13.4
Conventional curing barns:	92.2	37.2
Less than 3	3.2	3.2
3 - 8.99	22.5	20.1
9 - 14.99	22.6	10.1
15 - 19.99	15.0	2.6
20 - 34.99	17.7	1.2
35 or more	11.2	0

Table 9.—Optimal harvest systems by operation size and production area

Operation size by acres of tobacco grown	Study area			
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29
	Harvest systems[1]			
Less than 3	221	111	111	221
3-8.99	221	131	131	152
9-14.99	221	152	[2] 131,221	152
15-19.99	131	162	152	[2] 152,221
20-34.99	[2] 231,352	262	262	262
35 or more	352	352	352	352

[1] Codes refer to harvest systems described in table 2. [2] A combination of two systems is optimal because of labor, machinery, and equipment constraints within the models. This does not necessarily mean that each system is equally profitable.

STRUCTURE, TECHNOLOGY, AND THE DEMAND FOR TOBACCO LABOR THROUGH 1980

Flue-cured tobacco harvest mechanization has progressed at a rapid pace since 1972. Harvest in 1974 took about 175 hours of labor per acre—12 hours less than in 1972 (*3*). About 10 percent of the 1974 crop was mechanically harvested compared with about 1 percent of the smaller 1972 crop. Bulk barns were used to cure 20 percent of the crop, up from the 8 percent in 1972. An estimated 38 percent of the 1975 crop was cured in bulk barns and 18 percent mechanically harvested (*7*).

During the 1972-74 period, pressures from inflation provided farmers with a strong incentive to adopt new harvest technology to improve cost efficiency. Wage rates advanced 26 percent. And the prices of LP gas and fertilizer, important inputs in producing flue-cured tobacco, increased more than 100 percent. In total, production costs rose about 37 percent (*1*). Many farmers could do little to offset these price increases, especially for nonlabor inputs, as only limited input substitution was feasible. However, on some farms cost efficiencies could be attained through capital-labor substitution, for example, adoption of bulk curing systems.

The relationship of wage rates to prices of bulk barns and mechanical harvesters is undoubtedly a major factor in decisionmaking. When an investment is made in a laborsaving system, on the one hand, the price of that investment is fixed over its useful life. That is, future price changes are avoided until a replacement purchase is made. The appropriate price

Table 10.—Total labor used for harvesting by harvest job with actual and optimal harvest systems

Job	Actual	Optimal	Percentage difference
	1,000 hours of labor		*Percent*
Walking primer	12,686.4	9,293.2	-26.7
Riding primer	6,286.3	3,786.7	-39.8
Hander	4,905.3	649.1	-86.8
Hand looper	6,370.1	2,373.3	-62.7
Bulk racker	637.8	4,026.1	+531.2
Tractor driver	5,267.7	3,866.5	-26.6
Priming aid driver	600.9	320.7	-46.6
Mechanical harvester driver	([1])	319.8	0
Tying machine worker	7,262.3	3,296.0	-54.6
Shaker	1,358.8	603.6	-55.6
Hang tobacco in conventional barn	6,873.2	2,738.6	-60.2
Fill bulk barn	410.3	3,084.0	+651.6
Take tobacco out of barn	5,020.8	3,908.6	-22.2
Prepare tobacco for market	12,662.0	7,519.3	-40.6
Other[2]	1,821.7	1,127.9	-38.1
Total harvest labor	72,163.6	46,913.4	-35.0

[1] No systems using mechanical harvester drivers appeared in the survey. [2] Includes all jobs not easily categorized.

for calculating comparative capital costs of new harvest systems is therefore the price at time of purchase. Harvest workers, on the other hand, must be hired annually and wage changes are not avoided. The appropriate wage rate for calculating comparative annual labor costs is the average expected rate over the useful life of the harvest system. Thus, at any point in time that the mechanization decision is being considered, capital costs are calculated at the current price. But comparative labor costs are calculated at the expected wage rates over the life of the system. For example, if consideration is given in 1975 to purchase a harvester with a useful life of 10 years, annual harvester costs are based on the 1975 price. Labor costs for the harvester and for the system it replaces are based on expected wage rates for the 1975-85 period.

The projections and analysis that follow assume farm wage rates that are 50 percent higher than in 1972 and nonfarm wages that are 40 percent higher. Inherent in this assumption is the expectation of an average annual increase of about 10 percent in farm wage rates for any 10-year period beginning between 1972 and 1980. From 1960 to 1970, farm wage rates in North Carolina rose 93 percent or at an average annual rate of 9.3 percent. Prices for harvest system durables were held constant at the 1972 level.

It should be recognized that this further assumes that the ratio of wage rates to the prices of harvest system durables will not change over the projection period. To show the effect of the wage rate assumption, projections based on no change in relative wage rates are also presented.

Projected Structure of Tobacco Farms

As mechanization advances, the number and size distribution of flue-cured tobacco farms will change. Strongly influencing this structural change and the rate of mechanization is the tobacco production control program. Initiated under the Agricultural Adjustment Act of 1938, the program regulates the amount of tobacco production marketable by allotment holders. In turn, the size of designated allotments (or quotas) has significantly influenced the feasibility of adopting capital intensive systems.

Since 1972, successive annual increases in the flue-cured tobacco quota brought the basic quota in 1974 to a level that was 27 percent more than actual 1972 marketings. This shifted the size distribution of flue-cured tobacco farms upward and contributed to the recent increases in the rate of mechanization. Marketing quotas were again increased 15 percent in 1975. And although the 1976 basic quota was reduced, it still exceeded 1972 output by 24 percent.

Also influencing the structure of flue-cured tobacco farms is the lease-and-transfer provision of the tobacco program. Enacted in 1961, this provision has permitted the redistribution of tobacco quota among farms within the same county. For the lessees, the program provides the opportunity to acquire, on a temporary basis, enough quota to allow labor, management, and specialized equipment to be used more profitably in producing tobacco. Consolidating production into larger operating units through lease-and-tranfer has caused a gradual decline in the number of farms producing tobacco.

In 1972, the study area contained an estimated 40,545 farms that produced flue-cured tobacco. Nearly 80 percent of them used some form of rental or leasing arrangement to acquire tobacco quota. Of the 385,000 acres produced on these farms (9.5 acres per farm), about 71 percent or 6.7 acres per farm were acquired by renting, leasing, or both.

About 19 percent of the tobacco farms in the study area in 1972 grew less than 3 acres of tobacco, and 62 percent grew less than 9 acres (table 11). However, these farms produced only 26 percent of the 1972 tobacco crop. Farms that produced 20 acres or more of tobacco constituted only 10 percent of the farms, but they produced 34 percent of the output.

With the growing incentive to mechanize harvest operations and continuation of the present flue-cured tobacco program, optimal linear programing solutions point to further declines in the number of farms that produce tobacco and striking shifts in the size distri-

Table 11.—Distribution of farms and production by size, 1972 and projected 1980

Operation size by acres of tobacco grown	Actual 1972 production		Projected 1980 level of production					
			Low		Medium		High	
	Farms	Tobacco production	Farms	Tobacco production	Farms	Tobacco production	Farms	Tobacco production
	Percent of total							
Less than 3	19.1	3.2	20.2	5.8	0	0	0	0
3-8.99	42.6	23.0	51.9	37.4	35.6	14.2	20.4	6.2
9-14.99	19.5	23.5	17.2	25.7	26.9	21.7	23.4	14.1
15-19.99	8.6	15.8	7.5	17.6	17.1	20.7	28.0	22.5
20-34.99	7.7	21.1	2.5	9.2	16.5	29.4	19.9	29.8
35 or more	2.5	13.4	.7	4.3	3.9	14.0	8.3	27.4

bution of their tobacco acreage. For the three alternative quota levels analyzed, the decline in number of tobacco farms in the study area ranges from 18 to 37 percent during the 1972-80 period.

The most significant decline in farms producing tobacco is projected for a 50 percent reduction in 1972 quotas. Under this "low" quota situation, the number of farms producing tobacco declines nearly 15,100 units (table 12). The number declines in all size groups with the smaller farms gaining a larger share of production. In particular, if quotas are lowered 50 percent, the proportion of tobacco produced

Table 12.—Projected optimal distribution of farms by size for alternative levels of quota, 1980

Quota level and operation size by acres of tobacco grown[1]	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
	Number of farms				
Low quota:					
Less than 3	1,489	2,480	0	1,168	5,137
3-8.99	2,464	6,672	2,144	1,942	13,222
9-14.99	831	1,764	1,391	384	4,370
15-19.99	129	451	1,304	32	1,916
20-34.99	257	219	150	17	643
35 or more	67	46	43	11	167
Total	5,237	11,632	5,032	3,554	25,455
Medium quota:					
Less than 3	0	0	0	0	0
3-8.99	2,567	4,959	0	1,948	9,474
9-14.99	1,181	3,291	1,727	968	7,167
15-19.99	205	1,358	2,679	300	4,542
20-34.99	873	1,663	1,568	284	4,388
35 or more	411	361	211	54	1,037
Total	5,237	11,632	6,185	3,554	26,608
High quota:					
Less than 3	0	0	0	0	0
3-8.99	2,156	3,088	0	1,535	6,779
9-14.99	1,021	3,764	2,251	728	7,764
15-19.99	873	2,119	5,445	857	9,294
20-34.99	1,032	2,660	2,313	611	6,616
35 or more	797	1,218	528	190	2,733
Total	5,879	12,849	10,537	3,921	33,186

[1] Farms were reclassified from the 1972 size distribution (table 1) into new size groups after adjusting tobacco acres for quota changes and optimal leasing arrangements.

by farms with less than 9 acres could increase from 26 percent in 1972 to 43 percent by 1980.

Unlike the "low" quota situation, adjustment to a 1972 level or to a 50-percent higher level of production by 1980 is projected to shift upward the proportion of tobacco produced by farms in each size group. Optimal solutions show that for these two situations, lease-and-transfer of all quota out of the farms with less than 3 acres is feasible. With a "high" quota situation, the number of tobacco farms is estimated to decline 18 percent, and 57 percent of the tobacco crop is projected to be produced by farms with 20 acres or more.

For all three quota levels, the most decline in the number of tobacco farms is projected to be in the Piedmont area of North Carolina and Virginia. In 1972, nearly 71 percent of the Piedmont farms harvested less than 9 acres of tobacco per farm. For the entire study area, under 1980 conditions, the model projects that quota would be leased from the smaller farms and transferred to larger units—particularly farms with 15 to 35 acres (table 13). Most farms of this size were only partly mechanized in 1972. They used such systems as 221 (riding primers-conventional barns) and 152 (walking primers-bulk barns) and were operating at less than full capacity. With additional allotment, these operators could more fully use their equipment and facilities.

Although operators of the large tobacco farms in the study area can also profitably increase tobacco production, the cost would be greater than for the intermediate size units—given the limited amount of tobacco transferred in the model. Most farms harvesting more than 35 acres of tobacco were already large enough in 1972 to justify mechanizing their tobacco harvest. Consequently, harvest equipment and facilities would need to be replicated to handle additional tobacco quota.

Table 13.—Estimated change in production among operation sizes from actual 1972 to optimal 1980 for low, medium, and high levels of quota

Quota level and operation size by acres of tobacco grown	Initial poundage quota[1]	Quota change[2]		Lease and transfer[3]		Estimated pounds produced by 1980	Change between 1972 and 1980
		In	Out	In	Out		
	Million pounds						*Percent*
Low quota:							
Less than 3	12.0	21.7	0	0	12.0	21.7	-10.7
3-8.99	86.6	109.1	21.7	0	33.3	140.7	-18.8
9-14.99	88.4	96.8	80.6	0	7.8	96.8	-45.2
15-19.99	59.4	23.2	57.5	43.0	1.9	66.2	-44.2
20-34.99	79.2	29.1	78.3	5.3	.9	34.4	-78.2
35 or more	50.5	0	41.8	7.6	0	16.3	-83.8
Total	376.1	279.9	279.9	55.9	55.9	376.1	-50.0
Medium quota:							
Less than 3	24.3			0	24.3	0	-100.0
3-8.99	173.2			0	66.8	106.4	-38.6
9-14.99	176.7			0	13.9	162.8	-7.9
15-19.99	118.7			79.8	42.8	155.7	+23.8
20-34.99	158.1			64.1	1.0	221.2	+39.9
35 or more	100.9			4.9	0	105.8	+4.9
Total	751.9			148.8	148.8	751.9	0
High quota:							
Less than 3	36.3	0	25.9	0	10.4	0	-100.0
3-8.99	257.5	25.9	144.0	0	69.2	70.2	-59.5
9-14.99	265.4	144.0	208.3	11.9	54.0	159.0	-10.0
15-19.99	177.9	163.8	82.6	89.1	95.3	252.9	+113.1
20-34.99	237.2	127.1	154.8	127.6	1.7	335.4	+112.1
35 or more	151.6	154.8	0	2.0	0	308.4	+206.6
Total	1,125.9	615.6	615.6	230.6	230.6	1,125.9	+50.0

[1] The initial poundage quota was computed by operation size for three levels of tobacco quota as follows: (low level of quota) a level of production 50 percent below actual 1972 output, (medium level of quota) a level of production equal to actual 1972 output, and (high level of quota) a level of production 50 percent above actual 1972 output. [2] Quota change represents the redistribution of production among sizes after tobacco acreage is adjusted for the alternative levels of quota. [3] Lease and transfer represents the movement of quota among sizes to optimize the objective criteria.

For the small tobacco farms, cropland (averaging about 15 acres per farm in 1972) limits the expansion of tobacco production. Many small producers use family labor and profitably produce tobacco with labor intensive systems. But as wage rates increase, the opportunity cost of this labor rises and nonfarm jobs become more attractive.

Maximum Adoption by 1980

Projections to 1980 show a potential for rapid mechanization of the flue-cured tobacco harvest. The magnitude of the shift in technology will depend mainly on farm wage rates and the size of tobacco quotas.

For assumed 1980 conditions, 20 to 30 percent of the crop is projected to be harvested mechanically (table 14). In addition, about 65 percent of the crop will be harvested either by walking or riding primers and cured in bulk barns. In total, more than 80 percent of the tobacco produced in the study area is expected to be harvested with less labor intensive systems by 1980.

Table 14.—Projected percentage harvested with optimal harvest systems for low, medium, and high levels of quota, 1980

Harvest system[1]	Level of quota		
	Low	Medium	High
	Percent of pounds		
Bulk curing barns:	86.5	89.3	92.0
Hand harvest (152,162)	47.6	45.2	44.7
Riding primer (252,262)	18.0	22.5	17.2
Mechanical harvester (352)	20.9	21.6	30.1
Conventional curing barns:	13.5	10.7	8.0
Hand harvest (111)	0	0	0
Riding primer (211,221)	3.8	1.6	.6
Tying machine (131)	9.7	8.7	6.7
Riding primer and tying machine (231)	0	.4	.7

[1] Codes refer to harvest systems described in table 2.

Most noticeable will be the substantial increase in bulk curing systems. Bulk barns afford considerable labor savings over conventional barns, regardless of whether they are used with mechanical harvesters or walking and riding primers. The optimal solutions of this analysis indicate that by 1980 it will be feasible to mechanically harvest all of the flue-cured tobacco produced on units of 35 acres or more in the Pee Dee-Lumber River area, Coastal Plain, and Georgia. The same should apply to most of the 35-acre or larger units in the Piedmont area and some 20- to 35-acre units in all regions.

Not all conventional systems will be displaced by 1980. For farms of 3-8.99 acres in the Coastal Plain, the 131 (walking primers, tying machine) system will still compete with bulk systems. In the Pee Dee-Lumber River area, the 221 (riding primers, riding hand loopers) and 231 (riding primers-tying machine) systems will still be used on a few intermediate-size farms. For farmers producing less than 3 acres of tobacco, the most profitable choice in 1980 will be to either lease-in additional quota to justify new harvest technology or lease-out quota and reallocate the tobacco resources to other farm and nonfarm enterprises.

Tobacco Quotas and the Harvest Work Force

The size of the work force needed to produce flue-cured tobacco is related directly to the volume of production and the level of harvest mechanization employed. Clearly, an increase in acreage produced will serve to decrease the number of job opportunities lost because of mechanization. Likewise, quota declines intensify displacement of tobacco labor.

The 1972 tobacco harvest in the study area took 72.2 million hours of labor (9.6 hours per 100 pounds) and employed an estimated 325,000 harvest workers (tables 15 and 16). Mechanization response to expected wage rates at this production level could reduce harvest labor use about 33.2 million hours by 1980. The slight decline in projected preharvest and marketing labor use during the 1972-80 period is minimal for a 1972-sized crop. It reflects only the labor savings incurred when tobacco quotas are transferred to units with higher yields per acre—this permits the same level of output from slightly fewer acres.

With a "low" quota situation, farmers could be expected to use about 36 million hours of labor to produce the 1980 crop. This is a reduction of 51.8 million hours of harvest labor and 18 million hours of preharvest and marketing labor from the labor used in 1972.

Even if 1980 quotas are 50 percent greater than in 1972, farmers could feasibly mechanize and reduce harvest labor use 23 percent to nearly 55.5 million hours. But because of the increased need for preharvest and market labor to produce a 50-percent larger crop, total labor use over the entire study area would probably decline less than 5 percent. Even Georgia, requiring more total labor to produce 50-percent larger quotas, would use about 12 percent less harvest labor.

Characteristics of People Affected

From this analysis it is evident that during the next few years a potential exists for a substantial reduction in harvest labor used, and mechanization can be expected to proceed at a fairly rapid pace. The projected decline in harvest labor used (per 100 pounds) during the 1972-80 period for the three quota levels is shown in figure 2. Because tobacco harvest work is

Table 15.—Projected labor use for low, medium, and high quotas by region, 1980

Study area and job	Actual (1972)	Level of quota		
		Low	Medium	High
		Million hours		
Pee Dee-Lumber River, N.C.-S.C. 16:				
Preharvest and marketing	6.3	3.0	6.0	9.0
Harvest	14.2	3.8	6.9	9.1
Total	20.5	6.8	12.9	18.1
Coastal Plain, N.C. 17:				
Preharvest and marketing	13.3	6.3	12.7	18.9
Harvest	30.8	8.4	16.7	23.9
Total	44.1	14.7	29.4	42.8
Piedmont, N.C.-Va. 18:				
Preharvest and marketing	10.8	4.6	9.2	13.7
Harvest	19.9	6.1	11.1	16.1
Total	30.7	10.7	20.3	29.8
Georgia, Ga. 29:				
Preharvest and marketing	3.2	1.7	3.4	4.9
Harvest	7.3	2.1	4.3	6.4
Total	10.5	3.8	7.7	11.3
All areas:				
Preharvest and marketing	33.6	15.6	31.3	46.5
Harvest	72.2	20.4	39.0	55.5
Total	105.8	36.0	70.3	102.0

Table 16.—Estimated labor force by type of worker, 1972

Type of worker	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
			Number		
Operator family[1]	18,600	33,100	51,200	9,200	112,100
Regular hired	1,850	4,700	1,050	600	8,200
Sharecropper family[1]	5,700	5,200	10,400	2,100	23,400
Seasonal hired[2]	38,200	87,800	34,200	21,300	181,500
Total	64,350	130,800	96,850	33,200	325,200

[1] Exchange workers are assumed to be either operator or sharecropper family members who exchange labor with other tobacco growers. Thus, for purposes of estimating the total flue-cured tobacco harvest labor force, they are included with operator or sharecropper families. [2] Assumes each seasonal hired worker provides 260 hours of harvest labor annually.

seasonal, this projected decline in the need for harvest workers points to a loss of part-time jobs.

If the "high" quota situation prevails, preharvest labor needs will exceed those in 1972. However, it is doubtful that this would provide many job opportunities for seasonal tobacco harvest workers. Hoover and Perkinson found very little overlap of hired workers for harvest and preharvest tasks, indicating they may constitute two separate work force groups.[10] Transplanting is likely to require more workers, particularly to pull plants. Plant bed and field preparation

[10] Information obtained from personal communication with Hoover and Perkinson.

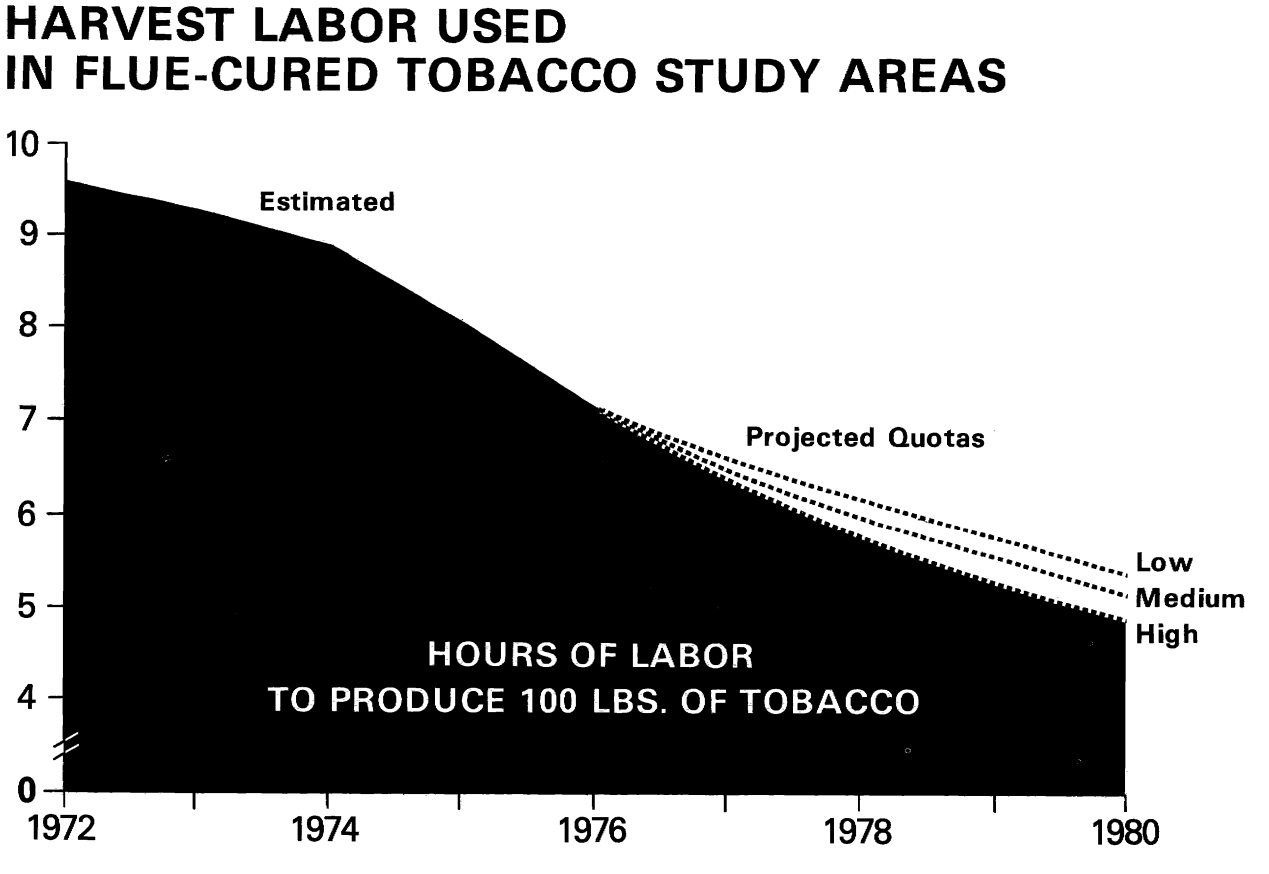

Figure 2

and cultivation will not require more workers, but rather, some workers will likely provide more hours of labor for a larger sized crop.

Comparing "worker requirements" of mechanized harvest systems with those of conventional systems expected to be replaced gives some insight into which workers might be affected by reduced harvest employment opportunities. The change to bulk barns will virtually eliminate the need for handers, hand loopers, shakers, and tying machine labor. More than 90 percent of the workers performing these tasks in 1972 were young persons (mainly 12 to 15 years old) and women. Use of walking and riding primers will also be substantially reduced as automatic harvesters become more widely adopted. Greater use of bulk systems will expand the need for rackers and barn loaders and unloaders. Favored for these tasks will be young and middle-aged able-bodied men. In 1972, men performed 80 percent of the harvest work for bulk systems, compared with 61 percent for conventional systems.

Adjustment of harvest systems to a "high" quota situation could reduce the labor needed for handers, hand loopers, shakers, and tying machine workers by as much as 17.7 million hours (89 percent) by 1980 (see tables 6 and 17). Nearly 70 percent of this labor

Table 17.—Projected total labor used by harvest job and area for low, medium, and high levels of quota, 1980[1]

Quota level and job	Study area				
	Pee Dee-Lumber River N.C.-S.C. 16	Coastal Plain N.C. 17	Piedmont N.C.-Va. 18	Georgia Ga. 29	All areas
	Million hours				
Low quota:					
Walking primer	0.44	2.05	1.79	0.55	4.83
Riding primer	.28	.55	.28	.10	1.21
Hander	0	0	0	0	0
Hand looper	.28	0	0	0	.28
Bulk racker	.21	1.07	1.24	.41	2.93
Tractor driver	.35	.78	.54	.19	1.86
Priming aid driver	.10	.03	.01	,01	,15
Mechanical harvester driver	.10	.05	.02	.03	.20
Tying machine worker	.15	.63	0	0	.78
Shaker	.03	.11	0	0	.14
Hang tobacco in conventional barn	.22	.26	0	0	.48
Fill bulk barn	.34	.79	.88	.33	2.34
Take tobacco out of barn	.35	.74	.58	.21	1.88
Prepare tobacco for market	.86	1.19	.64	.24	2.93
Other[2]	.12	.15	.10	.04	.41
Total harvest labor	3.83	8.40	6.08	2.11	20.42
Medium quota:					
Walking primer	.93	4.03	2.76	1.22	8.94
Riding primer	.29	1.16	.91	.09	2.45
Hander	0	0	0	0	0
Hand looper	.24	0	0	0	.24
Bulk racker	.43	2.16	2.25	.83	5.67
Tractor driver	.70	1.54	1.02	.38	3.64
Priming aid driver	.25	.06	.04	0	.35
Mechanical harvester driver	.22	.09	.05	.05	.41
Tying machine worker	.20	1.25	0	0	1.45
Shaker	.04	.23	0	0	.27
Hang tobacco in conventional barn	.22	.52	0	0	.74
Fill bulk barn	.89	1.58	1.54	.68	4.69
Take tobacco out of barn	.67	1.47	1.03	.43	3.60
Prepare tobacco for market	1.66	2.38	1.23	.48	5.75
Other[2]	.18	.30	.22	.08	.78
Total harvest labor	6.92	16.77	11.05	4.24	38.98
High quota:					
Walking primer	1.12	5.89	3.84	1.91	12.76
Riding primer	.25	.90	1.48	.03	2.66
Hander	0	0	0	0	0
Hand looper	.13	0	0	0	.13
Bulk racker	.73	3.16	3.27	1.25	8.41
Tractor driver	.98	2.19	1.49	.57	5.23
Priming aid driver	.36	.04	.07	0	.47
Mechanical harvester driver	.37	.33	.07	.10	.87
Tying machine worker	.12	1.65	0	0	1.77
Shaker	.02	.30	0	0	.32
Hang tobacco in conventional barn	.13	.69	0	0	.82
Fill bulk barn	1.45	2.56	2.23	1.05	7.29
Take tobacco out of barn	.94	2.24	1.50	.67	5.35
Prepare tobacco for market	2.27	3.47	1.81	.74	8.29
Other[2]	.23	.44	.33	.11	1.11
Total harvest labor	9.10	23.86	16.09	6.43	55.48

[1] Labor used for all harvest tasks beginning with priming of leaves up to and including market preparation. [2] Includes all jobs not easily categorized.

may be hired women and persons less than 18 years of age (tables 18 and 19). Use of primers and the conventional barning crew may decline by about 9.6 million hours. Preparation of loose leaf tobacco could use 4.4 million fewer hours of labor.

Since the tobacco harvest is seasonal, it offers employment to many part-time workers. Hoover and Perkinson found in a labor market survey for selected areas of North Carolina that hours worked per person to harvest flue-cured tobacco were quite low, 260 on average, reflecting the relatively short harvest season (*5*). Using this coefficient, the projected 16.7-million hour decline in labor needs from 1972 to 1980 for the "high" quota situation translates into a net reduction of 64,000 harvest workers.

Declines in harvest job opportunities will not be

Table 18.—Projected decline in job opportunities by type of worker for low, medium, and high levels of quota, 1972-80[1]

Quota level and job	Type of worker			
	Family		Hired	
	Operator	Sharecropper	Regular	Seasonal
	Million hours			
Low quota:				
Walking and riding primers	2.87	0.47	0.45	9.15
Hander	.92	.23	.07	3.69
Hand looper	1.17	.25	.18	4.49
Tractor driver	1.32	.16	.14	1.79
Priming aid driver	.18	0	.02	.25
Tying machine worker	2.00	.31	.06	4.11
Shaker	.28	.02	.02	.90
Hang tobacco in conventional barn	1.58	.28	.22	4.31
Take tobacco out of barn	1.55	.22	.11	1.26
Prepare tobacco for market	2.76	.42	.29	6.26
Other[2]	.39	.06	.04	.92
Total decline in harvest labor[3]	15.02	2.42	1.60	37.13
Medium quota:				
Walking and riding primers	1.57	.26	.28	5.47
Hander	.92	.23	.06	3.70
Hand looper	1.17	.25	.18	4.53
Tractor driver	.63	.07	.07	.86
Priming aid driver	.10	0	.02	.13
Tying machine worker	1.79	.28	.06	3.68
Shaker	.24	.02	.02	.81
Hang tobacco in conventional barn	1.51	.27	.22	4.13
Take tobacco out of barn	.70	.10	.05	.57
Prepare tobacco for market	1.96	.30	.21	4.44
Other[2]	.30	.04	.03	.67
Total decline in harvest labor[3]	10.89	1.82	1.20	28.99
High quota:				
Walking and riding primers	.40	.07	.17	2.91
Hander	.67	.20	.08	3.96
Hand looper	1.00	.25	.23	4.76
Tractor driver	.02	0	0	.02
Priming aid driver	.05	0	.01	.07
Tying machine worker	1.59	.13	.06	3.71
Shaker	.24	0	.02	.78
Hang tobacco in conventional barn	1.42	.20	.24	4.19
Prepare tobacco for market	1.17	.14	.14	2.92
Other[2]	.19	.02	.02	.48
Total decline in harvest labor[3]	6.75	1.01	0.97	23.80

[1] Labor used for all tasks beginning with priming of leaves up to and including market preparation. [2] Includes all jobs not easily categorized. [3] This is the total decline in flue-cured tobacco harvest labor from actual 1972 (table 6) to optimal 1980 for a low, medium, and high level of quota. Only tasks which are expected to offer fewer job opportunities over the 1972-80 period are shown in this table. Many of the workers displaced from the tasks associated with conventional systems may be used in the bulk systems as bulk rackers, bulk barn loaders, and mechanical harvester drivers. The decline is distributed proportional to the work contribution of the specified types of workers by job in 1972.

Table 19.—Projected decline in job opportunities for low, medium, and high levels of quota by age and sex of hired workers, 1972-80

Quota level and job	Age and sex of hired workers					
	Less than 18 years old		18 to 45 years old		More than 45 years old	
	Male	Female	Male	Female	Male	Female
	Million hours					
Low quota:						
Walking and riding primers	4.78	0.36	3.55	0.39	0.42	0.10
Hander	.39	2.07	.14	.89	.04	.23
Hand looper	.15	1.34	.23	2.51	.03	.41
Tractor driver	1.11	.07	.43	.04	.25	.03
Priming aid driver	.15	.01	.09	0	.02	0
Tying machine worker	.40	.96	.30	2.13	.07	.31
Shaker	.30	.10	.30	.11	.10	.01
Hang tobacco in conventional barn	1.78	.39	1.65	.37	.25	.09
Take tobacco out of barn	.53	.11	.47	.15	.08	.03
Prepare tobacco for market	2.52	.52	2.25	.74	.38	.14
Other[1]	.31	.11	.31	.12	.10	.01
Total decline in hired work[2]	12.42	6.04	9.72	7.45	1.74	1.36
Medium quota:						
Walking and riding primers	3.84	.25	2.08	.26	.25	.07
Hander	.39	2.07	.14	.89	.04	.23
Hand looper	.16	1.35	.23	2.52	.03	.42
Tractor driver	.54	.03	.21	.02	.12	.01
Priming aid driver	.08	.01	.05	0	.01	0
Tying machine worker	.36	.86	.27	1.91	.06	.28
Shaker	.27	.09	.27	.10	.09	.01
Hang tobacco in conventional barn	1.71	.38	1.58	.35	.24	.09
Take tobacco out of barn	.24	.05	.21	.07	.04	.01
Prepare tobacco for market	1.79	.37	1.59	.53	.27	.10
Other[1]	.23	.08	.22	.09	.07	.01
Total decline in hired work[2]	9.61	5.54	6.85	6.74	1.22	1.23
High quota:						
Walking and riding primer	1.48	.21	1.02	.19	.13	.05
Hander	.42	2.23	.15	.95	.04	.25
Hand looper	.16	1.43	.24	2.68	.04	.44
Tractor driver	.01	0	.01	0	0	0
Priming aid driver	.04	0	.04	0	0	0
Tying machine worker	.37	.87	.27	1.92	.06	.28
Shaker	.26	.09	.26	.10	.08	.01
Hang tobacco in conventional barn	1.73	.39	1.62	.36	.24	.09
Prepare tobacco for market	1.18	.24	1.04	.35	.18	.07
Other[1]	.16	.05	.16	.06	.05	.02
Total decline in hired work[2]	5.81	5.51	4.81	6.61	0.82	1.21

[1] Includes all jobs not easily categorized. [2] This is the total decline in flue-cured tobacco harvest labor for all hired workers shown in table 18. Only tasks which are expected to offer fewer job opportunities over the 1972-80 period are shown in this table. Many of the workers displaced from the tasks listed above may be used in the bulk systems as bulk rackers, bulk barn loaders, and mechanical harvester drivers. The decline is distributed proportionally to the work contribution of the specified types of workers by job in 1972.

spread uniformly among all types of workers. Job losses will probably be heaviest among the seasonal hired laborers who work only during the tobacco harvest. For the "high" quota situation, about 91,500 fewer seasonal workers are expected to be needed by 1980 to perform conventional harvest tasks. But, the accompanying change to bulk systems will provide alternative job opportunities for some of these displaced laborers. Included in these jobs will be the need for approximately 30,000 more bulk rackers, 26,500 more bulk barn loaders, and 1,300 more barn unloaders. Also, about 3,300 mechanical harvester drivers will be needed. However, it is expected that operators and regular hired workers will drive these machines. Assuming seasonal workers maintain their 1972 proportion in the projected mix of harvest labor,

this leaves a minimum of 30,400 seasonal workers in the study area without a part-time job harvesting flue-cured tobacco.[11]

The remaining 33,600 harvest workers displaced under the "high" quota assumption will be regular hired labor and members of operator and sharecropper families. Of these three groups, sharecroppers are expected to be most expendable. It is anticipated that as operators invest large sums of capital in labor-saving bulk barns and automatic harvesters, they will become more reluctant to give sharecroppers part of the tobacco crop as a return for their labor contribution. This is not to imply that some sharecroppers would not be employed as hired workers.

The sharpest decline in harvest labor needs occurs with the "low" quota situation—a projected decline of about 200,000 harvest workers during 1972-80. About 126,500 of these would be seasonal hired workers. However, the decline in production alone (without further mechanization) would lower pre-harvest labor needs by about 18 million hours or 70,000 workers. For a 1972-sized crop in 1980, about 75,000 fewer seasonal hired workers and 52,000 fewer regular hired, operator, and sharecropper family workers would be needed in the study area if tobacco producers were to adopt the optimal mix of harvest technology.

Geographic Distribution of Tobacco Harvest Labor Adjustments

The impact that harvest mechanization might have on the labor force of an area is closely associated with the rate of adoption, other job opportunities, characteristics of harvest workers, and the concentration of tobacco production in the area. The greater the number of nonfarm jobs, the easier a given labor adjustment will probably be. Similarly, displacement would be less severe in areas of relatively low production density.

Of the four regions studied, the Coastal Plain of North Carolina is the most concentrated area of flue-cured tobacco production. Consequently, the tobacco labor force is larger, and the potential for displacement of harvest labor is greatest in this area. As indicated previously, the largest reduction in tobacco labor occurs with the "low" quota situation. It is estimated that with adoption of optimal tobacco harvest technology to a level of production that is 50 percent less than the 1972-sized crop by 1980, total labor needs could decline as much as 70 million hours from 1972 levels. For the harvest phase in the Coastal Plain, this amounts to a decline of 22.4 million hours or 86,000 workers in a 14-county area. Most of these will be seasonal part-time workers, since it is expected that members of operator families and regular hired workers will be used wherever possible. The average annual reduction in harvest workers would be about 770 workers per county. For a "high" quota situation in the Coastal Plain, the reduction would be about 240 workers per county per year.

Displacement of harvest workers would be less in the Pee Dee-Lumber River, Piedmont, and Georgia regions because of less concentrated production. For the "low" quota level, the projected decline in number of harvest workers needed by 1980 ranges from 53,000 fewer workers in the Piedmont (300 per county per year) to 20,000 fewer in Georgia (130 per county per year). With the "high" level of production, displacement of harvest workers is estimated to range from 19,600 fewer in the Pee Dee-Lumber River (223 per county per year) to 3,500 in Georgia (23 per county per year).

As shown in table 20, approximately 70 to 75 percent of the laborers used in the Pee Dee-Lumber River, Coastal Plain, and Georgia were seasonal workers in 1972. About three-fourths of these workers were persons less than 18 years of age and women. Thus, more than half of the harvest workers in the three regions were seasonal hired young persons and women. These are the population groups supplying most of the handers, hand loopers, and tying machine workers. So, they are likely to be first to lose harvest job opportunities. Moreover, since bulk systems tend to favor able-bodied men, young persons (especially those 12-15 years of age) and women are likely to be the last to realize new employment opportunities with mechanized systems.

In the Piedmont, however, seasonal workers provided less than 45 percent of the harvest labor used in 1972. Also, fewer young persons were used in this area, because the harvest season overlaps with the start of school. Consequently, a larger proportion of the labor displaced in the Piedmont will be family members.

Hoover and Perkinson, using a similar rationale, derived a "crude" estimate of who would bear the adjustment process. For a 40-percent decline in the demand for wage workers, they estimated that women would bear most of the decline. In their ranking of the order of employment decline, young females (12 to 17 years of age) account for 27 percent and young males (12 to 13 years old) account for 10 percent. They also point out that, "...two-thirds of the hired workers were less than 25 years of age," implying that, for many workers, tobacco harvest work is transitory from which most 'graduate' as they mature and complete schooling. Tobacco income will decline but adjustment will probably come relatively easy because of the large numbers of young workers (*5*).

[11]The logistics of putting together appropriate harvesting crews will affect the type of worker mix. Since operator family and regular workers would likely be preferred, the estimates of seasonal worker displacement are considered minimums.

Table 20.—Distribution of hired seasonal workers by age and sex

Study area	Age and sex of workers as a percentage of total						Seasonal labor as a percentage of harvest labor[1]
	Less than 18 years old		18 to 45 years old		More than 45 years old		
	Male	Female	Male	Female	Male	Female	
	Percent						
Pee Dee-Lumber River, 16 ..	33.6	15.2	24.5	21.9	3.4	1.4	68.8
Coastal Plain, 17	31.0	16.1	22.9	20.0	4.0	6.0	73.0
Piedmont, 18	29.8	8.8	32.6	20.4	5.9	2.5	43.8
Georgia, 29	39.5	17.4	25.6	13.1	2.6	1.7	74.9
All areas	32.4	14.6	25.5	19.6	4.1	3.8	64.4

[1] Harvest labor includes all labor beginning with priming of leaves and ending with market preparation.

Effect of Relative Wage Rate Changes

The levels of flue-cured tobacco harvest mechanization projected in the previous analysis would be less if the relative increases in farm and nonfarm wage rates were to fall short of 50 percent and 40 percent, respectively. For example, with no change in the 1972 wages relative to other input prices and a "medium" quota level, the optimal mix of harvest systems includes curing 65 percent of the tobacco crop with bulk barn systems and harvesting 17 percent with mechanical harvesters (table 21). This is about 24 percent less bulk curing than was projected for the increased wage rates. Harvest labor needs with this mix of systems would total about 46 million hours in the study area (table 22).

An increase in nonfarm wage rates, relative to farm wage rates and other input prices, would be expected to make off-farm employment attractive to a greater number of tobacco farmers and perhaps increase the amount of lease-and-transfer. Such an event might lead to additional consolidation of quota and further mechanization. However, when nonfarm wage rates are increased 40 percent, the effect on mechanization is minimal; bulk systems increase only 1 percent compared with optimal for 1972 wages (table 21 and 23).

A 50-percent increase in farm wage rates, relative to nonfarm wages and other input prices, does have a significant influence on mechanization. Under this assumption lease-and-transfer also increases, though not so much as with the higher nonfarm wage rates. The effect of higher farm wages on harvest costs, however, results in 14 percent more of the crop cured with bulk systems compared with the optimal mix for 1972 wage rates.

As was discussed earlier, the wage rate assumption of this analysis is based on judgement. One could suggest that some other projected wage rate is more realistic. Clearly, the magnitude of change projected for wage rates has a considerable influence on the results. Considering the extent of flue-cured tobacco mechanization in 1975, it would seem that an expected minimum mechanization in 1980 would fall

Table 21.—Projected percentage harvested with optimal harvest systems for selected farm and nonfarm wage rates and medium levels of quota, 1980

Harvest system[1]	Level of wage rates		
	1972 farm and nonfarm	1972 farm and 1972 nonfarm increased 40 percent	1972 farm increased 50 percent and 1972 nonfarm
	Percent of pounds		
Bulk curing barns:	65.1	66.1	79.3
Hand harvest (152,162)	31.8	30.7	42.1
Riding primer (252,262)	16.3	18.4	17.2
Mechanical harvester (352)	17.0	17.0	20.0
Conventional curing barns:	34.9	33.9	20.7
Hand harvest (111)	1.0	0	0
Riding primer (211,221)	14.4	14.4	2.5
Tying machine (131)	18.3	18.3	18.2
Riding primer and tying machine (231)	1.2	1.2	0

[1] Codes refer to harvest systems described in table 2.

Table 22.—Projected total labor used by harvest job for selected farm and nonfarm wage rates and medium levels of quota, 1980[1]

Harvest system	Level of wage rates		
	1972 farm and nonfarm	1972 farm and 1972 nonfarm increased 40 percent	1972 farm increased 50 percent and 1972 nonfarm
	Million hours		
Walking primer	9.0	8.7	10.3
Riding primer	4.0	4.2	2.0
Hander	.3	0	0
Hand looper	2.3	2.2	.4
Bulk racker	4.3	4.4	4.9
Tractor driver	3.8	3.8	3.8
Priming aid driver	.4	.4	.4
Mechanical harvester driver	.3	.3	.4
Tying machine worker	3.0	3.0	2.8
Shaker	.5	.5	.5
Hang tobacco in conventional barn	2.6	2.5	1.4
Fill bulk barn	3.3	3.3	4.3
Take tobacco out of barn	3.9	3.9	3.8
Prepare tobacco for market	7.4	7.2	6.6
Other[2]	1.1	1.1	.8
Total	46.2	45.5	42.4

[1] Labor used for all harvest tasks beginning with priming of leaves up to and including market preparation. [2] Includes all jobs not easily categorized.

Table 23.—Estimated change in lease and transfer of quota among sizes from actual 1972 to optimal for selected wage rates

Operation size by acres of tobacco grown in 1972	Transfer of 1972 quota at 22 cents per pound with—											
	1972 farm and nonfarm wage rates			1972 farm wage rates increased 50 percent and 1972 nonfarm wage rates			1972 farm wage rates and 1972 nonfarm wage rates increased 40 percent			1972 farm wage rates increased 50 percent and 1972 nonfarm wage rates increased 40 percent		
	Amount produced	Leased		Amount produced	Leased		Amount produced	Leased		Amount produced	Leased	
		In	Out		In	Out		In	Out		In	Out
	Million pounds											
Less than 3	14.2	0	10.0	6.8	0	17.4	2.6	0	21.6	8.9	0	15.3
3-8.99	180.1	6.9	0	173.9	.7	0	184.3	11.1	0	156.9	0	16.3
9-14.99	179.9	3.1	0	186.1	9.3	0	179.9	3.1	0	186.1	9.3	0
15-19.99	118.7	0	0	126.1	7.4	0	126.1	7.4	0	140.0	21.3	0
20-34.99	158.1	0	0	158.1	0	0	158.1	0	0	159.1	1.0	0
35 or more	100.9	0	0	100.9	0	0	100.9	0	0	100.9	0	0
Total	751.9	10.0	10.0	751.9	17.4	17.4	751.9	21.6	21.6	751.9	31.6	31.6

somewhere between the estimate based on no change in wage rates for "medium" quota (65 percent bulk barn and 17 percent mechanical harvest) and the estimate for "high" quota (92 percent bulk barn and 30 percent mechanical harvester). In fact, mechanical harvester adoption had already exceeded 17 percent by 1975.

REFERENCES

(1) Givan, William D., and Frederic L. Hoff, "Flue-Cured Tobacco Production Costs and Prices, 1972-74." *Tobacco Situation*, TS-149, U.S. Dept. Agr., Sept. 1974, pp. 37-42.

(2) Grise, Verner N., and others, *Structural Characteristics of Flue-Cured Tobacco Farms and Prospects for Mechanization*, U.S. Dept. Agr., Agr. Econ. Rpt. No. 277, Jan. 1975.

(3) _____, and Owen K. Shugars, "Flue-Cured Tobacco Harvest Costs and Labor Needs in 1974," *Tobacco Situation*, TS-148, U.S. Dept. Agr., June 1974, pp. 30-32.

(4) Heady, Earl O., and Wilfred Candler, *Linear Programing Methods*, Ia. State Univ., Ames, Ia.,, 1958.

(5) Hoover, Dale M., and Leon B. Perkinson, "Hired Tobacco Harvest Work Force Characteristics in an Eight-County Area of North Carolina," N. C. State Univ., at Raleigh. A paper presented at the Am. Agr. Econ. Assn. meeting at Columbus, Ohio, Aug. 1975.

(6) _____, and Charles R. Pugh, Probable *Location of Flue-Cured Production Under Modified Lease-and-Transfer Programs*, Cir. 557, N.C. State Univ. at Raleigh, Feb. 1973.

(7) Shugars, Owen K., and Frederic L. Hoff, "Flue-Cured Tobacco, Mechanization Development and Adjustments," U.S. Dept. Agr. A paper presented at the Nat. Agr. Outlook Conf., Washington, D.C., Nov. 1975.

APPENDIX TABLES

Appendix table 1.—Work performed by different tyyes of workers by harvest system, Pee Dee-Lumber River, N.C.-S.C. 16

Tobacco harvest system[1]	Type of worker				
	Operator family	Seasonal hired	Regular hired	Exchange worker	Sharecropper family
	Percent				
Conventional curing barns:					
111	16.1	71.8	0.7	7.9	3.5
131	18.3	72.9	2.7	2.3	3.8
211	13.8	60.8	0	25.4	0
221	22.2	58.5	2.1	10.3	6.9
231	19.9	76.1	3.5	0	0
Bulk curing barns:					
152	11.1	74.7	14.2	0	0
162	22.7	69.4	7.9	0	0
252	([2])	([2])	([2])	([2])	([2])
262	17.8	62.3	12.7	4.7	2.5
All systems	18.6	68.8	2.7	6.0	3.9

[1] Codes refer to harvest systems described in table. 2 [2] No observations were recorded for this harvest system in the survey.

Appendix table 2.—Work performed by different types of workers by harvest system, Coastal Plain, N.C. 17

Tobacco harvest system[1]	Type of worker				
	Operator family	Seasonal hired	Regular hired	Exchange worker	Sharecropper family
	Percent				
Conventional curing barns:					
111	16.4	71.9	6.1	1.1	4.5
131	21.9	73.2	1.2	2.4	1.3
211	11.6	65.2	7.0	1.2	15.0
221	18.0	76.0	3.5	1.1	1.4
231	16.6	76.3	6.0	.2	.9
Bulk curing barns:					
152	20.2	75.4	2.3	2.1	0
162	15.5	65.0	19.5	0	0
252	11.8	88.2	0	0	0
262	22.7	51.1	17.8	8.4	0
All systems	18.3	73.0	4.4	1.4	2.9

[1] Codes refer to harvest systems described in table 2.

Appendix table 3.—Work performed by different types of workers by harvest system, Piedmont, N.C.-Va. 18

Tobacco harvest system[1]	Type of worker				
	Operator family	Seasonal hired	Regular hired	Exchange worker	Sharecropper family
	Percent				
Conventional curing barns:					
111	38.8	42.1	0.1	9.6	9.4
131	40.5	42.6	.9	9.0	7.0
211	([2])	([2])	([2])	([2])	([2])
221	29.3	70.7	0	0	0
231	28.3	53.4	16.9	1.4	0
Bulk curing barns:					
152	22.9	37.7	0	28.7	10.7
162	29.0	60.2	0	10.8	0
252	15.9	71.9	0	12.2	0
262	11.8	72.2	0	13.4	2.6
All systems	38.5	43.8	1.5	9.1	7.1

[1] Codes refer to harvest systems described in table 2. [2] No observations were recorded for this harvest system in the survey.

Appendix table 4.—Work performed by different types of workers by harvest system, Georgia, Ga. 29

Tobacco harvest system[1]	Type of worker				
	Operator family	Seasonal hired	Regular hired	Exchange worker	Sharecropper family
	Percent				
Conventional curing barns:					
111	14.2	76.5	0	1.5	7.8
131	9.5	83.1	0	0	7.4
211	21.5	78.5	0	0	0
221	19.6	74.6	1.7	.9	3.2
231	7.4	88.2	4.4	0	0
Bulk curing barns:					
152	19.6	79.0	0	.6	.8
162	23.9	73.7	2.4	0	0
252	40.2	55.8	4.0	0	0
262	19.1	68.1	8.6	2.0	2.2
All systems	18.6	74.9	1.9	1.0	3.6

[1] Codes refer to harvest systems described in table 2.