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Farm MECHANIZATION

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FARM MECHANIZATION
Power Costs and Production Requirements In the Northern Coastal Plains[1]

By H. Brooks James *and* Frank D. Barlow, Jr.[2]

INTRODUCTION

The purposes of this bulletin are (1) to present basic information on the cost of operating farm tractors, tractor-drawn machinery, workstock, and equipment, and (2) to compare production costs and requirements for selected crops under mechanized and non-mechanized methods of farming.

Such an analysis will be helpful to farmers who plan to shift to the use of tractors and tractor-drawn machinery on their farms as well as to those whose farms are now largely mechanized but who may be planning future adjustments to use more efficiently the power they have.

Results set forth in this report apply particularly to the Northern Coastal Plains of North Carolina, where agriculture is dominated by the production of peanuts, cotton, and tobacco. Farmers in the area realize the economic possibilities of mechanizing their farming operations and are moving rapidly in that direction. So, it becomes important for several reasons to make available for their examination the comparative costs of mechanical and of animal power.

These reasons are: (1) Man labor can be utilized more efficiently with mechanical power; (2) the relaxation of controls on the manufacture of farm machinery, which will likely occur after the war, will make it possible for farmers to substitute mechanical power for mule power at a more rapid rate; and (3) price and cost relationships in the immediate postwar adjustment period will probably make it profitable for farmers to adopt the most efficient methods of production.

The Northern Coastal Plains was chosen for study because of the adaptability of its farming systems to mechanized methods, and the large number of highly mechanized farms already there. The data relating to costs and

[1] This is the first of two reports presenting the results of a study of mechanization in the Northern Coastal Plains of North Carolina. The second report deals more with conditions influencing tractor use and the implications on future mechanization.

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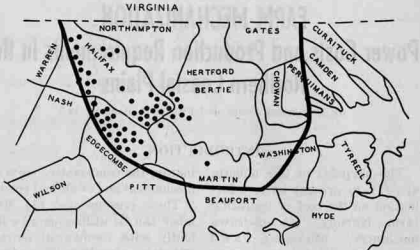

Figure 1.—Location of Farms Surveyed

requirements of mechanization were obtained from a survey of 61 farms which had mechanized practically all their farming operations by November, 1943, the time at which the farmers were interviewed.

The farms included in this survey were distributed as follows: 29 in Halifax County, 23 in Edgecombe, 6 in Bertie, and 3 in Martin (Figure 1). The data obtained from the survey were supplemented with information obtained from 128 non-mechanized farms in Halifax County in 1941. To make the data on the non-mechanized farms comparable with the present survey, adjustments for price changes between 1941 and 1943 were made.[3]

The 61 highly mechanized farms were selected at random from farms having at least a minimum degree of the farm operations performed with tractors. Only farms on which tractor power and machinery were used in planting and cultivating were included for study. The 128 farms surveyed in Halifax County in 1941 were selected at random from a stratified sample as to size and type. The data from these two surveys, including the adjustments to make them comparable as to time, form the basis for comparing the costs of mechanical and of animal power.

The type of power used in producing the various crops has a definite influence on the efficient use of other productive resources. In the last two sections of this report physical production requirements and total operating expenses for the principal crops are analyzed on the basis of the type of power used.

[3] The term "mechanization" as here used means that tractor power was used as well as mule power rather than exclusive of mule power, while "non-mechanized" means that tractor power was used only on a custom basis, for harvesting mainly, and most of the work was done by mule power.

COST OF OPERATING TRACTORS

There were 125 tractors in operation on the 61 mechanized farms. A record for each of these tractors provided the data for determining the cost of operating farm tractors in the area. The main variations in cost of operation are due to the size of tractor, the proportion of full capacity utilized, and the number of days used per year, and estimated days of useful life of the tractor. The association of each of these with cost of operation is explained briefly.

The tractors were divided into three size groups—small, medium, and large—on the basis of the draw-bar horsepower rating.[4] Tractors that were rated 16 horsepower or less were classified as small, those rating over 16 horsepower and less than 29 were classified as medium, and those rating 29 horsepower or over were classified as large. The average horsepower rating for the small group was 12.79, for the medium group 20.94, and for the large group 32.75.

The cost per 10-hour day of operating tractors of different sizes is summarized in Table 1. Total cost is made up of two kinds—cash or "out-of-pocket" outlays, and overhead, or annual share of the lifetime outlays. Each of these should be considered carefully by the farmer. The cash cost per 10-hour day is influenced by the amount of work done and the size of the tractor. The overhead cost is influenced principally by the number of days of use, the average life of the tractor, and the purchase price. It is often misleading to compare the cost of operating tractors of different sizes unless one recognizes that large tractors develop more horsepower and accomplish more work in a given time than do small tractors.

The purpose at this point in the report is to present the average cash costs of operation for small, medium, and large tractors, together with depreciation and interest. Depreciation is based on estimated life and days used in 1943. This provides valuable information for farmers who wish to compare the costs of operating tractors of different sizes, as well as to compare tractor and animal power costs.

Due to the influences of fac-

[4] See "Summary of Results of the Nebraska Tractor Tests," University of Nebraska, Department of Agricultural Engineering, Jan. 1, 1942. The horsepower ratings used were those determined in Test F giving 100 per cent maximum load.

TABLE 1.—Average cost of operating small, medium, and large tractors per 10-hour day, Northern Coastal Plains, 1943.

Item	Unit	Price per unit	Small tractors		Medium tractors		Large tractors		All tractors	
			Quantity	Cost	Quantity	Cost	Quantity	Cost	Quantity	Cost
		Dollars		Dollars		Dollars		Dollars		Dollars
Cash cost: (or cash equivalent)										
Gasoline	Gal.	.16	12.33	1.97	17.00	2.72	22.70	3.63	16.90	2.70
Oil	Qt.	.17	1.16	.20	1.33	.23	1.65	.28	1.34	.23
Grease	Lb.	.13	.26	.04	.38	.05	.45	.06	.37	.05
Oil filter	No.	.70	.12	.08	.15	.10	.10	.07	.14	.10
Service labor	Hr.	.30	.53	.16	.57	.17	.75	.22	.59	.18
Repairs				.80		.74		.77		.76
Total cash cost				3.25		4.01		5.03		4.02
Overhead cost:										
Depreciation				1.17		1.07		1.36		1.12
Interest[1]				.27		.28		.34		.29
Total overhead cost				1.44		1.35		1.70		1.41
Total cost per 10-hour day[2]				4.69		5.36		6.73		5.43
Average horsepower rating				12.79		20.94		32.75		21.02
Days worked per year (10-hour)				77		92		99		90
Days estimated life of tractor (10-hour)				724		948		1,000		900
Years estimated life of tractor				9.4		10.3		10.1		10.0
Average purchase price of tractor when new				$841.00		$1,015.00		$1,355.00		$1,028.00
Average cost per year of operation per tractor				$361.13		$493.12		$662.22		$488.70
Number of tractors				22		87		16		125

[1] Interest charge 5 per cent on one-half of the average purchase price.
[2] Does not include a charge for taxes, shelter, or other items not enumerated, nor for wages of operator.

tors affecting costs, they range considerably above and below the average shown in Table 1. The cost of gasoline makes up two-thirds of the total cash cost, varying from 61 per cent for small tractors to 72 per cent for large tractors.

The effects of the proportion of the full horsepower capacity utilized on the cost of operation are shown in Table 2. For instance, much more fuel is required per day or per hour for a heavy load such as breaking and disking than for a light load such as harrowing, planting, and cultivating. The variations in fuel consumption as there was no satisfactory way to allocate depreciation and repair costs under practical conditions where tractors were used for both light and heavy work.

The cost per day depends not only on the size of the tractor and the type of work, but also on the days worked during the year. The relationship between the number of days used per year and the cost of operating 87 medium size tractors per 10-hour day is presented in Table 3. Of this group 21 tractors were used less than 800 hours a year, at an average cost of 61 cents an hour. Twenty-four tractors were used from 800 to 1,000 hours at only those caused by differences

TABLE 2.—The effect of heavy and light loads on the average cost per hour for small, medium, and large tractors, Northern Coastal Plains, 1943.

Tractor size group	Number of tractors	Cost of operation per hour for		
		Heavy[1] load	Light[2] load	Average load
		Cents	Cents	Cents
Small	22	46.4	46.8	46.5
Medium	87	50.5	47.1	53.6
Large	16	77.2	57.4	67.3
All	125	60.3	48.3	54.3

[1] Heavy load includes breaking and disking.
[2] Light load includes cultivating, planting, combining small grain and soybeans, mowing, harrowing, and belt work.

TABLE 3.—The effect of annual days of use on the average cost of operation for 87 medium-size tractors, Northern Coastal Plains, 1943.

Annual days of use	Number of tractors	Average days of use	Average cost of operation	
			Per 10-hour day	Per hour
			Dollars	Cents
Under 80	31	62	6.13	61
80-100	24	91	5.55	56
Over 100	32	121	5.00	50
All tractors	87	92	5.36	54

an average cost of 54 cents an hour. The 32 tractors used over 1,000 hours a year were operated at a cost of 50 cents an hour.

"Out-of-pocket" costs per hour for fuel, motor oil, and other current items remain approximately constant for the same type of work regardless of the extent of use. Depreciation, interest, and repairs per hour depend mainly on the number of days the tractor is used per year. These items account primarily for the relationship between cost per hour of operation and the hours of annual use.

While the data presented are for 1943, they may be given a much wider application by using other levels of prices. For example, cash cost is dependent largely on the cost of gasoline which makes up nearly 70 per cent of the total. Other cash cost items could show considerable percentage changes and yet not affect the total appreciably. Economy in the use of fuel or fluctuations in its price has significant effects on unit costs. Overhead costs would be influenced by differences in purchase price and years of useful life. Any changes in average purchase prices from those used in this report would reflect the changes to be expected in the unit charge for depreciation and interest.

The kind of fuel used and its cost affect the cost of operating tractors. One hundred of the 125 tractors in this study used gasoline and 25 reported the use of kerosene or tractor fuel. So far, farmers prefer the use of gasoline. The margin between gasoline and other fuel prices is not sufficiently attractive to cause much shift in fuel use. Since gasoline was the most common fuel reported, the cost of operating all tractors is based on its use.

Farmers strongly prefer having tractors mounted on rubber tires to those on steel. The study showed that 109 tractors were mounted on rubber and only 16 were on steel (Table 4). Farmers estimated the expected life of rubber tires at 7 years for the large tires on the rear and 4.6 years for the front tires.

Variation in the life of tires depends on the treatment and the extent of annual use.

TABLE 4.—Number of tractors mounted on rubber and on steel and estimated life of rubber tires by size of tractor, Northern Coastal Plains, 1943.

Size of tractor	Tractor mounted on		Estimated life of rubber tires mounted on	
	Rubber	Steel	Rear wheels	Front wheels
	No.	No.	Years	Years
Small	18	4	7.3	5.1
Medium	77	10	6.8	4.4
Large	14	2	7.3	4.9
All tractors	109	16	7.0	4.6

COST OF OPERATING TRACTOR-DRAWN MACHINERY

Tractor costs make up only a part of the mechanization analysis. To complete the picture requires an appraisal of the cost of operating machinery used in conjunction with the tractor. The cost of operating mule or horse-drawn equipment and the cost of workstock, while receiving minor emphasis in this analysis, are presented to compare power costs and requirements. The cost of operating tractor-drawn machinery may be conveniently summarized in three parts: (1) combines, (2) peanut pickers, and (3) other tractor-drawn machinery.[5] A discussion of each of these follows.

Cost of Operating Combines

There is increasing emphasis in the area on shifting to crops that can be harvested by machinery. Small grains, lespedeza, and soybeans, as a war crop, have received the most emphasis. The use of combines is becoming more important as this change progresses.

The average cost per year of operating 49 six-foot combines with power take-off was $178.06, not including the wages of the combine operator. On the average, a combine was used to harvest 144 acres of grain, soybeans, and lespedeza at a cost of $1.24 per acre (Table 5).

Depreciation was the largest item of cost for operating combines and accounted for 59 per cent of the total. Annual repairs and upkeep accounted for approximately 30 per cent and interest amounted to 11 per cent of the total cost. Cash cost

[5] Principal items of power machinery and investment per farm are shown in Table 18.

TABLE 5.—Average cost per year and per acre of operating 49 six-foot combines in the Northern Coastal Plains, 1943.

Item	Cost per year	Cost per acre	Percentage of total cost
	Dollars	Dollars	
Repairs and upkeep[1]	53.00	.37	30
Depreciation[2]	105.13	.73	59
Interest[3]	19.93	.14	11
Total[4]	178.06	1.24	100
Harvested per combine, 144 acres			

[1] Average of farmers' estimates of the annual repair and upkeep costs.
[2] Average of the estimated purchase price was $799 for a combine without auxiliary motor, and the estimated useful life was 7.6 years.
[3] Interest charged at 5 per cent on one-half of the average purchase price.
[4] Does not include a charge for taxes and shelter. Excludes the cost of labor.

amounted to 37 cents per acre and overhead cost, 87 cents. Clearly, any great economy in the cost per acre must come through reductions in overhead cost, which can be accomplished only through harvesting a larger acreage per combine annually or by giving it better care in order to extend its useful life over a greater number of years and reduce annual depreciation. Cost per acre on different farms varied considerably from the average presented here because of differences in size of combine, the cost new, annual acreage harvested, and care given the machine.

Cost of Operating Peanut Pickers

This is an important peanut producing area and has received wartime impetus for greater quantities of peanuts. Therefore, peanut pickers are an essential part of the power machinery. The average cost per year of operating 56 peanut pickers was $115.60, not including wages for the crew required to operate the picker. Each machine picked an average of 124 acres at a cost of 93 cents an acre (Table 6).

Expenditure for repairs was the principal item of cost, accounting for 49 per cent of the total. Depreciation amounted to 38 per cent and interest on investment, 13 per cent. Cost per acre varied considerably above and below the average, depending mainly on the acreage picked per machine and the care with which the machine was operated.

Cost of Operating Other Tractor-Drawn Machinery

The investment in tractors and all tractor machinery varied from an average of about $2,500 on one-tractor farms to over $7,600 on three-tractor farms, or an average for all farms of nearly $4,900 (Table 7).

Tractors constituted the larg-

TABLE 6.—The average cost per year and per acre of operating 56 peanut pickers, Northern Coastal Plains, 1943.

Item	Cost per year	Cost per acre	Percentage of total cost
	Dollars	Dollars	
Repairs and upkeep[1]	56.00	.45	49
Depreciation[2]	44.45	.36	38
Interest[3]	15.15	.12	13
Total[4]	115.60	.93	100
Picked per machine, 124 acres[5]			

[1] Average of farmers' estimates of the annual repair and upkeep costs.
[2] Average of the estimated purchase price was $606, and the estimated useful life was 13.6 years.
[3] Interest charged at 5 per cent on one-half of the average purchase price.
[4] Does not include a charge for taxes and shelter. Excludes the cost of labor.
[5] Includes custom picking.

TABLE 7.—Average tractor and tractor machinery investment per farm and per acre in crops, and related data, for farms with one, two, or three tractors and for all farms, Northern Coastal Plains, 1943.

Item	One-tractor farms		Two-tractor farms		Three-tractor farms		Average for all farms[3]	
	Per farm	Per acre in crops	Per farm	Per acre in crops	Per farm	Per acre in crops	Per farm	Per acre in crops
	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.	Dol.
Investment (cost new basis) per farm:								
Tractors	1,026	4.09	1,986	4.86	3,351	5.94	2,056	4.49
Tractor machinery	826	3.29	1,510	3.69	2,410	4.27	1,515	3.31
Combines	322	1.28	716	1.75	1,206	2.14	799	1.74
Peanut pickers	354	1.41	555	1.36	669	1.17	545	1.19
Total	2,528	10.07	4,767	11.66	7,636	13.52	4,915	10.73
Repairs and upkeep:[3]								
Tractors	53	.21	146	.36	189	.33	137	.30
Tractor machinery	97	.39	92	.22	171	.30	113	.25
Combines	41	.16	92	.13	68	.12	63	.11
Peanut pickers	33	.13	42	.10	46	.09	50	.09
Total	224	.89	332	.81	476	.84	353	.77*
Depreciation:[4]								
Tractors	107	.43	187	.45	332	.59	206	.45
Tractor machinery	79	.31	138	.34	228	.40	145	.31
Combines	43	.17	95	.23	159	.28	105	.23
Peanut pickers	28	.11	40	.10	48	.08	40	.09
Total	257	1.02	460	1.12	747	1.32	496	1.08
Interest charges:[5]								
Tractors	26	.10	50	.12	84	.15	51	.11
Tractor machinery	21	.08	38	.09	60	.11	38	.08
Combines	8	.03	18	.05	30	.05	20	.05
Peanut pickers	9	.04	14	.03	16	.03	14	.03
Total	64	.25	120	.29	190	.34	123	.27

[1] Average for 17 farms with one tractor, 39 farms with 2 tractors, 12 farms with 3 tractors, and 3 farms with more than 3 tractors per farm.
[2] Average of farmers' estimates for 1943.
[3] Average of farmers' estimates for 1943.
[4] Depreciation is based on the average of farmers' estimates of useful life.
[5] Interest charge 5 per cent of one-half of the purchase price.
* Below average for the three groups shown because of the influence of 3 farms with 4 or more tractors.

est item of investment and upkeep, with combines and peanut pickers next in rank as separate items of machinery. These three items—tractors, combines, and peanut pickers—accounted for more than two-thirds of the total investment, repairs, depreciation, and interest per farm. The average investment in other tractor machinery, excluding tractors, combines, and peanut pickers, was $826 on farms with one tractor, $1,510 on farms with two tractors, $2,410 on farms with three tractors, and $1,515 for all farms.

Tractor and tractor machinery investment and cost per acre in crops tended to increase with the number of tractors per farm (Table 7). Two-tractor farms were about average for investment, depreciation, and interest. Three-tractor farms were above average and one-tractor farms were below average for all farms. The main reason for this was the lower average acreage in crops per tractor for the farms with more than one tractor. Repairs per acre in crops showed little variation with number of tractors, being more closely associated with actual tractor use which is largely reflected in acres in crops.

One-tractor farms had an average of 251 acres in crops, but two- and three-tractor farms averaged 205 and 188 acres in crops per tractor, respectively. Other important organization factors and their association with number of tractors per farm are shown in Table 8.

The average cost of operating other tractor machinery, *i.e.*, excluding tractors, combines, and peanut pickers, was $1.83 per 10-hour day, 18 cents an hour or 65 cents an acre (Table 9). Depreciation amounted to approximately 50 per cent of the total cost, repairs 38 per cent, and interest 12 per cent.

The cost of operating other tractor-drawn machinery varied from farm to farm, but it was higher on the average when the acreage in crops was small and lower when the acreage was large. While tractor-drawn machinery cost per farm increased with the size of farm, as a rule, the cost per acre declined (Table 10). The cost per acre depended more on the number of days the machinery was used than on the size of the farm. The reason the cost per acre was lower on farms with more than 499 acres in crops is that the machinery was utilized more fully. The cost averaged higher on farms with less than 250 acres in crops because the machinery was not used to its maximum capacity. Custom work is one way for the operator with a small acreage to utilize the machinery more fully, thus reducing the cost per hour of operation.

TABLE 8.—Average acres in crops, tractor-drawn machinery investment per acre in crops, and related data for farms with one, two, or three tractors, and for all farms, Northern Coastal Plains, 1943[1].

Item	Farms with			
	One tractor	Two tractors	Three tractors	Average all farms[2]
Acres in crops[3]	251	409	564	458
Acres in row crops	232	337	393	364
Acres in small grains and lespedeza	19	72	171	94
Number of workstock	8.3	11.0	15.3	13.0
Acres in crops per work animal	30.0	37.2	36.9	35.2
Number of farm families	5.3	8.0	10.9	10.0
Acres in crops per farm family	47.4	51.1	51.7	45.8
Investment per acre in crops[4]	$10.07	$11.65	$13.52	$10.73

[1] See footnotes for Table 7.
[2] Includes data for 3 farms with 4 or more tractors.
[3] Excluding cover crops.
[4] Includes investment for tractors, combines, peanut pickers, and other tractor-drawn machinery. Does not include mule-drawn equipment.

TABLE 9.—The cost of operation for tractor-drawn machinery, Northern Coastal Plains, 1943[1].

Item	Cost per year	Cost per hour	Cost per 10-hour day[2]	Cost per acre in crops[3]
	Dollars	Dollars	Dollars	Dollars
Repairs and upkeep	113	.07	.70	.25
Depreciation	145	.09	.90	.32
Interest[4]	38	.02	.23	.08
Total	296	.18	1.83	.65

[1] Excludes tractors, peanut pickers, and combines. For details see Table 18.
[2] Average cost per year divided by the average number of days tractors were used, excluding days used for picking peanuts and combining.
[3] Excluding cover crops, including small grains and lespedeza.
[4] Interest charge 5 per cent of one-half of the average purchase price.

TABLE 10.—The cost of operating tractor-drawn machinery per farm, and per acre in crops, by size of farm, Northern Coastal Plains, 1943[1].

Size of farm[2]	Number of farms	Average acres in		Machinery cost per farm	Cost per acre in	
		All crops[3]	Row crops		All crops[3]	Row crops
				Dollars	Dollars	Dollars
Less than 250 acres	20	170	153	179	1.05	1.17
250-499 acres	24	394	320	267	.68	.83
Over 499 acres	17	886	674	477	.54	.71
All farms	61	458	364	296	.65	.81

[1] Tractor machinery excludes tractors, combines, and peanut pickers.
[2] Acres in crops, excluding cover crops.
[3] Excludes acres in cover crops, includes small grains and lespedeza.

COST OF WORKSTOCK AND EQUIPMENT

On most farms, power is supplied both by tractors and by workstock. Within the area the range is from all workstock to none. The process of change to mechanical power may be rapid, but usually farmers move slowly in disposing of their stock when tractors are purchased.

Workstock were kept on 58 of the 61 farms in this study. The average number of workstock per farm for all farms was 13, most of which were mules. The usual practice of farmers was to feed work animals in a dry lot throughout the year as pasture was not available on most farms. Total annual cost per head for keeping workstock, excluding shelter and taxes, in 1943 was $197.87 (Figure 2).[6] Feed made up 73 per cent of the total cost. Corn and peanut hay were the main sources of feed.

The average amount fed per mule annually was 60 bushels of corn and 3 tons of peanut hay. The total and unit costs of workstock depend on prices of feed and the use of work animals. A sharp rise or fall in the prices of corn and peanut hay would influence the cost of workstock in the same way and would be the main influence in causing cost variations.

Depreciation amounted to 10 per cent of the annual workstock cost. The average cost of mules when purchased was $246.38 per head. The estimated years of useful life were 12.34, resulting in depreciation of $19.96 per mule annually, or 8.1 per cent of the average purchase price.

Other costs amounted to $34.09, or 17 per cent of the total. Chore labor per mule was 112 hours per year, which at 15 cents an hour was $16.80, or 8 per cent. The average estimated cost of harness per mule was $7.22, or 4 per cent. Interest at 5 per cent on one-half the average purchase price of the mules, or $123.19, increased the cost $6.16, or 3 per cent. Veterinary fees, medicine, and shoeing expenses were small, amounting to only $3.91 per mule, or 2 per cent. On most farms, the mules' feet were trimmed from two to three times a year. Very few mules were shod as they were not normally used for hauling on the highways.

[6] Total cost does not include a charge for taxes and shelter. Total cost is used in table instead of gross cost.

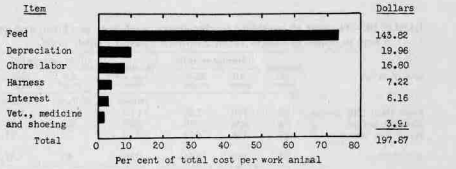

Figure 2. Principal cost items as percentages of total cost per work animal. The cost of keeping workstock in 1943 was relatively high as a result of high feed prices.

The annual cost of equipment pulled by workstock for farms operated with four or more mules was $17.72 per mule.

Data collected in 1941 on 128 mule-power farms in Halifax County indicated that mules worked an average of 800 hours per year, including hauling wood and other odd jobs. Assuming that this average rate applies generally to the area of which Halifax County is a part, the cost of mule labor based on 800 hours of work per year and on 1943 prices for feed, less the value of manure at $12 per mule, was 23 cents an hour. Workstock equipment costs averaged 2.2 cents an hour.

It is expected that the shift to tractors will continue as more tractors and tractor-drawn machinery become available and if farm incomes remain at a level which encourages commercial agricultural production. Under this trend, workstock costs will remain relatively high and displacement of workstock will continue. This being the case, farmers will not buy additional workstock if tractors are available. However, it must be kept in mind that some jobs will still be done by mules even though the cost per hour is high.

LABOR AND POWER REQUIREMENTS FOR SPECIFIED CROPS

The analysis so far has dealt with costs of using various types of power and power machinery. The farmers' interest in using different types of power is only incidental to getting those crops produced that will provide them with a maximum of income over production costs. Thus, the next step shall be to describe the effects of using different types of power on the man labor, and mule and tractor work requirements for specific crops.

The average rates of performing some of the more important field operations with tractors and with mules in the Northern Coastal Plains of North Carolina are shown in Table 11. These rates vary with the kind and amount of power and size of implement used. These data, as well as farmers' estimates, in-

dicate that one medium-size tractor will replace approximately six mules. No attempt is made to explore fully the effects of these factors on labor required to produce specified crops, except that the usual operations and the average rates of performance are compared for tractor power and mule power. The data in Table 11 provide a basis for calculating labor and power requirements for crops, using each type of power.

While the comparison of production requirements is made between tractor power and mule power, it should be pointed out that the comparison is for tractor power and mule power methods of production. Considerable animal power was available on the 61 mechanized farms studied. It is obvious that certain phases of agricultural production on these farms were performed with mules and that on most of the farms, both mules and tractors were used.

Cotton. In the Northern Coastal Plains, tractor power is adaptable to all phases of cotton production except hoeing and harvesting, which are still performed by hand. The man, mule, and tractor requirements per acre for producing cotton with

TABLE 11.—Accomplishments of tractors and mules in the Northern Coastal Plains.

Operation	Tractor[1]			Mule[2]		
	Size of implement	Hours per acre	Acres covered per 10-hour day	Size of implement	Hours per acre	Acres per 10-hour day per mule
Breaking	5 disk (tiller	0.8	12.5	1-mule	7.1	1.4
				2-mule	10.6	0.9
Disking	6 feet	0.5	20.0	2-mule	5.0	2.0
Harrowing (spike tooth)	12 feet	0.3	33.3	2-mule	2.0	5.0
Running rows	....	..	....	1-mule	1.7	5.9
Distributing fertilizer	....	..	....	1-mule	1.9	5.3
Ridging or listing (cotton)	....	..	....	1-mule	3.5	2.9
Ridging or listing (peanuts)	....	..	....	1-mule	2.0	5.0
Planting (average all crops)	....	..	....	1-mule	1.6	6.2
Planting (corn and soybeans)	2-row	0.7	14.3	[3]	[3]	[3]
Planting (cotton and peanuts)	2-row	0.8	12.5	[3]	[3]	[3]
Cultivating (all crops)	2-row	0.6	16.7	1-mule	2.8	3.6
Cultivating (all crops)	....	..	....	2-mule	2.9	3.4
Drilling grain	8 feet	0.5	20.0	....	..	....
Combining (grain and beans)	6 feet	0.8	12.5	....	..	....
Cutting hay (lespedeza)	7 feet	0.7	14.3	2-mule	1.5	3.3
Digging peanuts	2-row	0.8	12.5	1-row	2.5	4.0

[1] Average for 61 mechanized farms, 1943.
[2] Average for 128 farms operated with mules, 1941.
[3] Included in planting all crops.

TABLE 12.—Labor and power required per acre to produce cotton with tractor power and with mule power, Northern Coastal Plains.

Operation	Tractor power			Mule power		
	Hours per acre			Hours per acre		
	Man	Mule	Tractor	Man	Mule	Tractor
Preparation of seed bed and planting	3.4	..	2.9	15.2	21.8	..
Cultivating, hoeing, and side dressing	22.4	..	4.2	36.8	18.6	..
Harvesting	82.5	2.0	..	82.5	2.0	..
Total	107.9	2.0	7.1	134.5	42.4	..

tractor power and mule power are shown in Table 12.

Only about one-fifth as much man labor was required for the preparation of the seed bed and planting with tractor power as with mule power. For cultivating and side dressing, the man labor required was about three-fifths as much where tractor power was used. Labor for hoeing was approximately the same for each type of power. Relatively more man labor was saved in the preparation of seed bed and planting, but the greatest saving in total hours was in cultivating and side dressing. Since hand labor is used for harvesting cotton by both methods of production, the labor requirement is the same. The total man labor required per acre was reduced about 27 hours, or 20 per cent where tractor power was used.

Peanuts. Tractor power is more applicable to the production of peanuts than to the production of cotton, as indicated by the greater relative reduction in man labor required to produce an acre of peanuts with tractor power. In 1943 the only hand-labor practices in peanut production followed on tractor-operated farms were hoeing, applying land plaster, and stacking.

By using tractor power instead of mules, the preparation of the seed bed and planting was accomplished in about one-fourth the time, resulting in a reduction of 10.6 hours an acre; 20 per cent or 3.7 hours less man labor was required for cultivating and applying land plaster; and 5 per cent less man labor was required for harvesting. Labor requirements for hoeing are not appreciably changed by the use of different types of power. The total man labor required where tractors were the source of power was reduced 16 hours, or 24 per cent. Man, mule, and tractor requirements per acre are shown in Table 13.

Corn. Production of corn is well adapted to the use of tractors and modern machinery. The

TABLE 13.—Labor and power required per acre to produce peanuts with tractor power and with mule power, Northern Coastal Plains.

Operation	Tractor power			Mule power		
	Hours per acre			Hours per acre		
	Man	Mule	Tractor	Man	Mule	Tractor
Preparation of seed bed and planting	3.4	..	2.9	14.0	20.0	..
Cultivating, hoeing, and top dressing	14.8	..	5.0	18.5	14.5	..
Harvesting	32.8	7.5	2.4	34.5	10.0	1.6
Total	51.0	7.5	10.3	67.0	44.5	1.6

same power machinery that is used for other crops is suitable for corn. In 1943, hoeing and harvesting were the only operations performed by hand labor on the mechanized farms in this area. Harvesting can be mechanized but would require a harvester that could not be used for other crops.

Man, mule, and tractor requirements per acre are shown in Table 14.

A reduction of 18.1 hours an acre, or over one-half of the man labor required with mule power, was possible. This resulted about equally from more rapid preparation of seed bed and planting and from cultivation and side dressing.

Soybeans. Production of soybeans is better adapted to the use of tractor power than cotton, peanuts, and corn because all production operations may be performed with tractor machinery. The difference in hours of man labor required for the two methods of production was largest for the preparation of seed bed and planting (Table 15). The preparation and planting operations required about one-fourth as much labor with tractors as with mules.

TABLE 14.—Labor and power required per acre to produce corn with tractor power and with mule power, Northern Coastal Plains.

Operation	Tractor power			Mule power		
	Hours per acre			Hours per acre		
	Man	Mule	Tractor	Man	Mule	Tractor
Preparation of seed bed and planting	2.9	..	2.3	11.2	12.6	..
Cultivating, hoeing, and side dressing	3.5	..	2.4	13.3	12.2	..
Harvesting	10.0	3.0	..	10.0	3.0	..
Total	16.4	3.0	4.7	34.5	27.8	..

TABLE 15.—Labor and power required per acre to produce soybeans for beans with tractor power and with mule power, Northern Coastal Plains.

Operation	Tractor power			Mule power		
	Hours per acre			Hours per acre		
	Man	Mule	Tractor	Man	Mule	Tractor
Preparation of seed bed and planting	2.6	..	2.3	9.8	17.0	..
Cultivating	2.4	..	2.4	7.7	7.7	..
Harvesting[1]	2.2	..	0.8	2.5	0.9	0.8
Total	7.2	..	5.5	20.0	25.6	0.8

[1] A truck was used 0.3 hour per acre for hauling beans on farms using tractors. Beans were hauled with mules and wagon on farms using mules.

Small grains. Small grain production operations were performed entirely with tractor machinery on mechanized farms. The only operation performed with tractor power on farms using mule power was harvesting, which was hired on a custom-rate basis. A total man labor reduction of 8.2 hours, or about 57 per cent, resulted with tractor power. One-fourth as much man labor was required for the preparation of the seed bed and planting with tractors as with mules. Harvesting required slightly more labor under mule power conditions because of the time required to haul the grain to the barn. On farms using tractors, a truck was used for hauling the grain, while on other farms, mules and a wagon were used. Man, mule, and tractor hours required per acre are shown in Table 16.

TABLE 16.—Labor and power required per acre to produce small grains with tractor power and with mule power, Northern Coastal Plains.

Operation	Tractor power			Mule power		
	Hours per acre			Hours per acre		
	Man	Mule	Tractor	Man	Mule	Tractor
Preparation of seed bed and planting[1]	2.5	..	2.3	10.2	18.0	..
Top dressing	1.2	..		1.2		
Harvesting[2]	2.4	..	0.8	2.9	2.6	0.8
Total	6.1	..	3.1	14.3	20.6	0.8

[1] Grain seeded with drill on farms using tractors. Grain seeded by hand and covered with harrow on farms using mules.
[2] Grain hauled in with truck on farms using tractors. Grain hauled in with mules and wagon on farms using mules. Combine used on all farms.

OPERATING EXPENSE FOR SPECIFIED CROPS

The amount of labor saved per acre by using tractor power is only part of the total saving in the production of important crops. Farmers are interested finally in knowing how *total* op-

erating expenses compare when using different types of power for the important crops that can be produced with machinery. Consequently, the next step is to present data showing comparative operating expenses for cotton, peanuts, corn, soybeans, and small grains. The expenses are itemized to show man labor, mule work, tractor work, equipment, and other items and the share each is of the total.

The comparison of operating expenses[2] by type of power used points out the relative merits of the two methods of production measured in terms of specific operating items. It is not intended to be a means of determining the total cost of producing crops. *The costs of land and of management* are not included. These particular costs per acre of crops may or may not be the same with different types of power. No attempt has been made to determine these costs or the extent to which they vary from farm to farm. Expenses other than land and management are analyzed in detail because they include the items which change significantly in the mechanization process. These are presented for contrast in Table 17, and are described in detail as each of the major crops of the area is discussed.

Cotton. The operating expense per acre for producing cotton was $8.62 less where tractors were used (Table 17).[3] This was a saving of 18 per cent.

Expense items, such as seed and fertilizer, were assumed to be the same for each method of production. In arriving at the harvesting expense as a part of the operating expense per acre, the average (1937-1941) yield of 309 pounds of lint per acre for the Northern Coastal Plains was used.

Individual expense items varied considerably for the two types of power. For example, mule work amounted to 21 per cent of the total operating expense with mule power, and only one per cent where tractors were used. In contrast, tractor and equipment expense accounted for 13 per cent of the total where tractors were used, and only 2 per cent where mules were the main source of power. The expense for man labor was $3.51 less with tractors, but the relationship of labor expense to the total was approximately the same in both situations. Expenses for seed, fertilizer, and other items remained the same regardless of type of power and comprised a larger proportion of the total with tractor power.

Peanuts. The operating expense per acre for producing peanuts was $11.65 less where

[1] Hours at 1940 prices.
[2] Does not include cost of land and management.

TABLE 17.—Principal operating expense items per acre for cotton, peanuts, corn, soybeans, and small grains with tractor power and mule power, Northern Coastal Plains, 1943.

Items of expense	Cotton		Peanuts		Corn		Soybeans		Small Grains	
	Tractor power	Mule power	Tractor power	Mule power	Tractor power	Mule power	Tractor power	Mule power	Tractor power	Mule power
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Man labor[1]	16.32	19.83	7.99	9.26	2.64	5.07	1.32	2.70	1.04	1.87
Mule work	.46	9.75	1.72	10.23	.69	6.38	....	5.89	....	4.74
Tractor work	3.83	....	5.56	....	2.54	....	2.97	....	1.67	....
Equipment	1.28	.93	2.60	.98	.85	.61	2.23	.56	1.80	.46
Other items[2]	16.56	16.56	14.84	23.89	5.24	5.24	2.19	7.41	6.00	10.00
Total expenses	38.45	47.07	32.71	44.36	11.96	17.30	8.71	16.56	10.51	17.07
Reduction by using tractor power instead of mule power	$8.62		$11.65		$5.34		$7.85		$6.56	
Percentage reduction is of mule power expense	18.3		26.3		30.9		47.4		38.4	

[1] Tractor driver at 19.5 cents an hour, and common labor at 14.7 cents an hour.
[2] The contract rates were as follows: Picking peanuts, 50 cents a bag; baling peanut hay, 10 cents a bale; combining soybeans, including 1.6 hours of man labor, $5.56 an acre; combining small grains, including 1.6 hours of man labor, $4.00 an acre.

tractors were used (Table 17).[9] This was a saving of 26 per cent. This reflects the greater adaptation of tractor power to peanut production than to cotton. Seed, fertilizer, bags, and other items were the same for both methods of production. Harvesting expense as a part of the operating expense per acre was based on the average (1937-1941) yield of 1,263 pounds of nuts per acre for the Northern Coastal Plains.

To bring out as clearly as possible the contrast between tractors and mules as sources of power, the expenses for picking and for baling on mule-power farms were estimated at the prevailing custom rates of 50 cents a bag and of 10 cents a bale and were included in other items. Where tractors were used, the equipment charge included the expenses for the picker and the baler. The expenses for pickers and balers were much less when they were available on the farms than when they were obtained at custom rates and accounted for much of the difference in total expense per acre between tractor and mule power.

Mule work amounted to 23 per cent of the total operating expense where mules were used as compared with only 5 per cent for mechanized methods. Tractor work and machinery, including the picker and the baler, amounted to 25 per cent of the total operating expense with mechanical power, while the equipment charge for mules was only 2 per cent of the total.

Corn. The operating expense per acre for corn was reduced $5.34, or 31 per cent, when tractor power was used (Table 17).[9] This saving resulted about equally from the use of less man labor and the greater economy of tractor power in corn production. Expenses for seed, fertilizer, and other items were the same for both types of power. Further economy may be expected if farmers adopt corn pickers and establish custom rates that permit efficient operation of pickers. In relation to total expense, man labor and mule work were relatively less and tractor work, equipment, and other expenses relatively more when tractor power was used.

Soybeans. The production of soybeans on tractor-operated farms is completely mechanized. Mechanization has resulted in relatively greater savings in operating expense per acre than for cotton, peanuts, or corn. On non-mechanized farms, mule power is used for all operations in soybean production except harvesting. Harvesting expense on farms operated with mules was calculated at prevailing custom rates and was included in other items.

[9] Does not include cost of land and management.

The operating expense per acre for soybeans was $7.85 less where mechanization was complete (Table 17).[10] This was a reduction of 47 per cent. The cost of mule power and equipment, excluding the combine, on farms operated with mules, was $1.25 more per acre than the cost of tractor power and equipment, including the combine, on farms operated with tractors. The charge for combining was included in other items where mules were used.

Small Grains. The production of small grains was completely mechanized on tractor farms. On farms having only mule power, harvesting was hired at the prevailing custom rate and included in other items. The equipment expense included the combine where tractor power was used.

Variations in the average expense for producing wheat, oats, or barley are minor. The expense of producing wheat is presented as a typical example of producing small grains. The operating expense per acre was $6.56 less with mechanical power (Table 17).[10] This was a saving of 38 per cent.

[10] Does not include the cost of land and management.

SUMMARY

The discussion of farm mechanization in the Northern Coastal Plains of North Carolina was developed along three lines. First, an analysis was made of the cost of operating different types of tractors and machinery, and of workstock and workstock equipment. Attention was directed next to the effects of using different types of power on man labor, mule and tractor requirements, by operations, for five principal crops. Finally, these first two phases were brought together into an analysis of operating expenses contrasting tractor power and mule power methods of production. The outstanding points brought out in the study are summarized as follows:

1. The average cost of operating small tractors, based on 1943 prices, was 47 cents an hour; medium-size tractors, 54 cents; and large tractors, 67 cents. The average for all tractors was 54 cents. This does not include the wages of the tractor driver, taxes, or shelter charge. Variations from average costs for each size group are influenced by size of load and amount of use. The chief items that influence costs are fuel and depreciation.

2. The average cost of operation per hour varies with the size of load. With an average load, the cost per hour for all tractors was 54 cents; with a light load, 48 cents; and with a heavy load, 60 cents.

3. The average cost of operation varies with the amount of use. Medium size tractors that were used less than 800 hours a year resulted in an operating cost of 61 cents an hour; from 800 to 1,000 hours, 54 cents; and over 1,000 hours, 50 cents.

4. Tractors, combines, and peanut pickers accounted for 68 to 71 per cent of the total farm investment in tractors and all tractor-drawn machinery, and of the annual charge for repairs, depreciation, and interest.

5. The average tractor-drawn machinery investment was $10.73 per acre in crops, excluding cover crops. Farms with three tractors had a relatively higher investment per acre, while one-tractor farms were below the average. This was due to larger acreages in crops per tractor on the one-tractor farms.

6. The average annual cost of operating 49 six-foot combines with the power take-off was $178.06. The average six-foot combine harvested 144 acres of grain, soybeans, and lespedeza at a cost of $1.24 per acre, exclusive of the wages of labor.

7. The average annual cost of operating 56 peanut pickers, exclusive of the wages of labor, was $115.60. The average machine picked 124 acres of peanuts at a cost of 93 cents per acre.

8. The average cost of using tractor-drawn machinery other than combines and peanut pickers was $1.83 per 10-hour day, 18 cents an hour or 65 cents an acre.

9. The average total cost per year, at 1943 prices, of keeping workstock, excluding the cost of shelter and taxes, was $197.87 per head; the credit for manure was $12.00 per head, leaving an average net cost per year of $185.87.

10. Mules on non-mechanized farms worked an average of 800 hours per year at a net cost of 23 cents an hour, excluding cost of shelter and taxes.

11. High feed prices accounted for the relatively high cost of animal power in 1943. Feed accounted for 73 per cent of the total cost of keeping workstock.

12. Workstock equipment cost averaged 2.2 cents per hour of use.

13. On the basis of the average work performed, one medium-size tractor could have replaced approximately six mules.

14. Mechanized methods of farming required fewer hours of man labor to produce the principal field crops in 1943. The largest relative reduction in total labor requirements was obtained for soybeans, small grains, corn, peanuts, and cotton in that order.

15. Operating expense per acre in crop production was less where tractor power was used. The relative reduction in operating expense per acre in 1943 was largest for soybeans, followed by small grains, corn, peanuts, and cotton.

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TABLE 18.—Average tractor-drawn machinery inventory and related data for all farms reporting, Northern Coastal Plains, 1943[1].

Item	Number per farm	Size range	Cost new	Investment per farm	Age	Years of use left	Estimated life	Annual depreciation	Annual repairs
			Dollars	Dollars	Yrs.	Yrs.	Yrs.	Dollars	Dollars
Tractor	2.0	S-L	1,028	2,056	4.1	5.9	10.0	206	137
Disk	1.3	5'-8'	206	268	4.8	5.1	9.9	27	24
Disk tiller	1.1	4d-8d	225	248	3.8	6.4	10.2	24	15
Harrow	1.0	6'-16'	38	38	4.8	5.5	10.3	4	3
Planter[2]	1.0	2 R	190	190	3.5	6.4	9.9	19	8
Cultivator[2]	1.4	2 R	175	245	3.4	7.2	10.6	23	20
Drill	.5	8'-16'	184	92	3.9	7.9	11.8	8	9
Mower	.5	6'-8'	141	70	3.3	6.7	10.0	7	14
Rake	.2	8'-16'	159	32	2.4	7.4	9.8	3	5
Baler	.6		440	264	4.7	7.6	12.3	21	13
Peanut picker	.9		606	545	6.5	7.1	13.6	40	50
Combine	1.0	6'	799	799	3.5	4.1	7.6	105	53
Other equipment[3]				68				9	2
Total				4,915				496	353
Total, excluding tractors, peanut pickers, and combines				1,515				145	113

[1] Average for 61 farms. Acres in crops (excluding cover crops), 458; acres in row crops, 364; acres in small grains and lespedeza, 94; number of work-stock, 12.9; number of working families, 9.5.
[2] Includes attachments.
[3] Includes miscellaneous or special equipment such as rotary hoe, stalk cutter, bush and bog harrow, cultipacker, peanut digger, lime sower, etc.

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