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STAFF PAPER

DERIVED LABOR REQUIREMENTS FOR CENTRAL KANSAS CROPS

LARRY N. LANGEMEIER, CHRIS AKHIMIEN,
AND KIM WITT*

August 1990
No. 91-9

Department of Agricultural Economics
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DERIVED LABOR REQUIREMENTS FOR CENTRAL KANSAS CROPS*

*Larry N. Langemeier, Chris Akhimien, and Kim Witt***

A significant change in agriculture has been the decrease in labor required per crop acre with the continuous shift to larger machinery and equipment. The larger machinery permits producers to handle more crop acres. Hours of labor available for crop production decreased 2.1 percent between 1975 and 1989 on Kansas Farm Management Association, N.C. and S.C., cash crop dryland farms; total crop acres increased 33.5 percent.[1]

Producers, agri-business firms, and others need current information on crop-labor requirements. Management considerations of new machinery investments, additional land purchases, enterprise analyses, and cost of production budgets require labor information for various crops. The rapid changes in machine sizes and field operations call for current crop-labor standards.

DATA CONSIDERATIONS AND METHODOLOGY

Information on tillage, planting, and harvesting-machine operations was obtained from Farm Management Association fieldmen.[2] Also, machinery dealers provided information on small, average, and large machine sizes for their trade areas and their expectations on future machine sizes. Specific information required for each crop was: type of machine operations, machine sizes, months machines were used, and number of times over a given acre for each machine (see Appendix Tables 1-8).

Machine sizes vary by farm size. Three farm sizes were considered based on farms enrolled in the north central (N.C.) and south central (S.C.) Farm Management Associations: small (150-550 crop acres); average (550 - 1,400 crop acres); and large (more than 1,400 crop acres). Among these farm sizes, only the machine size was adjusted.

A computerized machinery investment generator program[3] was used to develop the "field time" or "machine hour" requirements for each crop, considering machinery type and size and number of tillage, planting, and harvesting operations. Machine hours--hours that a machine must be operated to complete a specific operation for one acre--were computed by this formula:

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*Contribution No. 91-89-D from the Kansas Agricultural Experiment Station.

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[1]Larry N. Langemeier, "The Annual Report, Management Information, 1975 and 1989," Department of Agricultural Economics, Cooperative Extension Service, Kansas State University, Manhattan, Kansas, 66506.

[2]Farm management fieldmen from Kansas Farm Management Associations, N.C. and S.C., provided most of the information on machine sizes and operations.

[3]A micro-computer model was developed specifically for this project as a means of estimating crop-labor standards and machinery investment requirements.

$$\text{Hours per acre} = \frac{1.0}{((S) \times (W) \times (E)/8.25)}$$

Where, S = Average speed (mph) a machine travels
W = Machine's capacity in feet
E = Field efficiency of the machine

Field efficiency is the ratio of the actual capacity of a machine to its theoretical capacity. The field efficiency factor accounts for overlap and failure to use the machine's full operating width, turning time, and such machine servicing as filling seed boxes. Field efficiencies vary with sizes and shapes of fields and field conditions.

Field-labor hours were obtained by multiplying total machine hours by 1.25 to reflect additional time to travel to and from the field, adjust equipment, lubricate, and do repairs and maintenance work. Labor standards for each crop included an indirect labor charge of .125 (.0625 for alfalfa hay and sorghum silage) times field-labor hours for time required for accounting, managing, meetings, marketing, using auto and pickup, and purchasing repair parts.[4]

DERIVATION OF CROP LABOR REQUIREMENTS

Table 1 shows field-labor hour requirements by month for each crop. Though labor distribution during the year varies from farm to farm (depending on weather, field conditions, and when a given machine operation is done), total field-labor-hour requirements for a given crop will not be changed by shifting a machine operation to another month.

Table 2 shows field-labor-hour "standards" by month for each crop. The standards were derived by weighting the hours for small, average, and large sized farms by the proportion of total cash crop dryland farms in the 150-550, 550-1,400, and more than 1,400 crop acre categories, respectively, in Farm Management Associations, N.C. and S.C. Labor requirements per acre for grain and row crops ranged from 1.30 hours for oats to 2.28 hours for corn. Table 3 shows field-labor-hour standards for each crop on a percentage basis. Percentages would become important should labor standards change in the future.

Table 4 presents the tillage-planting, harvesting, and indirect labor requirements for the small, average, and large farms and the weighted standards.[5] Harvesting hours were similar for wheat, oats, soybeans, and grain sorghum because only combine size was varied. Crop yields, plant lodging, and field conditions are other factors that affect field efficiencies and, therefore, change harvesting-time requirements.

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[4]The field-labor-hour adjustment and indirect labor charge factors were 1.30 and .15 for eastern Kansas; 1.20 and .10 for western Kansas.

[5]Tillage-planting and harvesting requirements were derived from the information outlined in Tables 1 and 2. Custom tillage, planting, or harvesting operations were not considered.

Table 1. Estimated Field-Labor-Hours* per Acre for Indicated Crops, Small, Average, and Large Farms, Central Kansas, 1989**

Months	Wheat	Corn	Soybeans	Grain Sorghum	Oats	Sorghum Silage	Bromegrass***	Alfalfa Hay***
				(hours per acre)				
Small-size farm								
January								
February	0.03							
March		0.21		0.19	0.57	0.31		
April		0.97	0.21			0.25		0.08
May			0.26	0.42		0.25		1.76
June	0.61	0.25	0.10	0.15	0.61		1.76	1.87
July	0.40		0.25	0.25		0.25	0.02	1.78
August	0.42						0.02	0.14
September	0.30		0.08				0.03	0.34
October	0.08	0.98	0.76	0.62		4.02		
November		0.38	0.37	0.28	0.38			
December								
TOTAL	1.84	2.79	2.03	1.91	1.56	5.08	1.83	5.97

Table 1. Estimated Field-Labor-Hours* per Acre for Indicated Crops, Small, Average, and Large Farms, Central Kansas, 1989** (Continued)

Months	Wheat	Corn	Soybeans	Grain Sorghum	Oats	Sorghum Silage	Bromegrass***	Alfalfa Hay***
				(hours per acre)				
Average-size farm****								
January								
February	0.03							
March		0.15		0.16	0.37	0.25		
April		0.76	0.15			0.19		0.06
May			0.19	0.31		0.19		1.46
June	0.56	0.18	0.08	0.11	0.56		1.46	1.48
July	0.31		0.18	0.18		0.18	0.02	1.47
August	0.34						0.02	0.09
September	0.19		0.08				0.01	0.24
October	0.04	0.80	0.67	0.57		3.69		
November		0.32	0.30	0.24	0.32			
December								
TOTAL	1.47	2.21	1.65	1.57	1.25	4.50	1.51	4.80

Table 1. Estimated Field-Labor-Hours* per Acre for Indicated Crops, Small, Average, and Large Farms, Central Kansas, 1989** (Continued)

Months	Wheat	Corn	Soybeans	Grain Sorghum	Oats	Sorghum Silage	Bromegrass***	Alfalfa Hay***
				(hours per acre)				
Large-size farm								
January								
February	0.03							
March		0.12		0.14	0.27	0.22		
April		0.54	0.12			0.15		0.05
May			0.14	0.23		0.13		1.24
June	0.49	0.12	0.05	0.08	0.49		1.24	1.26
July	0.24		0.12	0.12		0.12	0.01	1.17
August	0.25						0.01	0.07
September	0.16		0.06				0.01	0.22
October	0.04	0.66	0.60	0.46		3.69		
November		0.27	0.27	0.21	0.27			
December								
TOTAL	1.21	1.71	1.36	1.24	1.03	4.31	1.27	4.01

*Field-labor hours (tillage-planting-harvesting) were computed by multiplying total machine hours-field time -by 1.25 to reflect the additional time required for traveling to and from the field, adjusting equipments, maintenance, lubrication, etc.

**Estimates are for 1989 using best sources available supplemented by actual farm information, although previous years' experiences would influence estimates.

***Tillage and planting operations for bromegrass and alfalfa hay were pro-rated over a 10 and 5-year periods, respectively.

****A representative or middle group of farms with acreage ranging from 550-1,400 crop acres.

Table 2. Derived Field-Labor Hour per Acre Standards for Indicated Crops, Central Kansas, 1989*

Months	Wheat	Corn	Soybeans	Grain Sorghum	Oats	Sorghum Silage	Bromegrass	Alfalfa Hay
				(hours per acre)				
January								
February	0.03							
March		0.16		0.16	0.41	0.26		
April		0.78	0.16			0.20		0.07
May			0.20	0.32		0.20		1.50
June	0.56	0.19	0.08	0.12	0.56		1.50	1.54
July	0.32		0.19	0.19		0.19	0.02	1.50
August	0.35						0.02	0.10
September	0.21		0.08				0.02	0.26
October	0.05	0.82	0.68	0.60		3.78		
November		0.33	0.32	0.26	0.33			
December								
TOTAL	1.52	2.28	1.71	1.65	1.30	4.63	1.56	4.97

*Derived by weighting hours in Table 1 for small, average, and large farms by the proportion of total farms represented by the number of cash crop-dryland farms with 150-550, 550-1400, and more than 1400 crop acres respectively, in Kansas Farm Management Associations, N.C. and S.C.

Table 3. Derived Field-Labor Hour per Acre Standards on a Percentage Basis for Indicated Crops, Central Kansas, 1989

Months	Wheat	Corn	Soybeans	Grain Sorghum	Oats	Sorghum Silage	Bromegrass	Alfalfa Hay
				(%)				
January								
February	1.97							
March		7.02		9.70	31.54	5.62		
April		34.21	9.36			4.32		1.41
May			11.70	19.39		4.32		30.18
June	36.84	8.33	4.68	7.27	43.08		96.16	30.99
July	21.05		11.11	11.52		4.10	1.28	30.18
August	23.03						1.28	2.01
September	13.82		4.68				1.28	5.23
October	3.29	35.96	39.77	36.36		81.64		
November		14.48	18.70	15.76	25.38			
December								
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Table 4. Tillage-Planting, Harvesting, and Indirect Labor Requirements per Acre for Indicated Crops, Central Kansas, 1989

	Small-Sized Farm				Average-Sized Farm			
Crop	Tillage-Planting	Harvesting*	Indirect**	Total	Tillage-Planting	Harvesting*	Indirect**	Total
	(hours per acre)							
Wheat	1.24	0.61	0.23	2.08	0.90	0.56	0.18	1.64
Corn	1.81	0.98	0.35	3.14	1.41	0.80	0.28	2.49
Soybeans	1.27	0.77	0.25	2.29	.94	0.71	0.21	1.86
Grain Sorghum	1.14	0.77	0.24	2.15	.86	0.71	0.20	1.77
Oats	0.95	0.61	0.20	1.76	0.69	0.56	0.16	1.40
Sorghum Silage	1.05	4.02	0.32	5.39	0.82	3.69	0.28	4.79
Bromegrass	0.07	1.76	0.23	2.06	0.04	1.46	0.19	1.69
Alfalfa Hay	0.61	5.36	0.37	6.34	0.27	4.54	0.30	5.11

	Large-Sized Farm				Derived Standards***			
Crop	Tillage-Planting	Harvesting*	Indirect**	Total	Tillage-Planting	Harvesting*	Indirect**	Total
	(hours per acre)							
Wheat	.72	0.49	0.15	1.36	0.96	0.56	0.19	1.70
Corn	1.06	0.66	0.22	1.94	1.46	0.82	0.28	2.56
Soybeans	0.75	0.61	0.17	1.53	1.00	0.70	0.21	1.91
Grain Sorghum	0.65	0.58	0.15	1.39	.95	0.70	0.20	1.80
Oats	0.55	0.49	0.13	1.17	0.73	0.56	0.16	1.45
Sorghum Silage	0.61	3.69	0.27	4.57	0.85	3.78	0.29	4.92
Bromegrass	0.04	1.24	0.16	1.44	0.05	1.50	0.19	1.74
Alfalfa Hay	0.20	3.83	0.25	4.28	0.34	4.63	0.31	5.29

*Harvesting hours includes both labor for operation of harvesting equipment as well as hauling of grain, silage, and hay production.

**Indirect labor was derived as .125 (.0625 for sorghum silage and alfalfa hay) times field-labor hours to account for accounting, management, attending meetings, marketing, using auto and pickup, and purchasing repair parts.

***Standard labor requirements were derived by weighting hours for small, average, and large farms by proportion of total farms represented by the number of cash crop dryland farms with 150-550, 550-1,400 and more than 1,400 crop acres, respectively, in Kansas Farm Management Associations, N.C. and S.C.

Table 5 shows the new and previous labor standards for each crop and the percentage changes. The new labor standards ranged from 4.35 to 21.09 percent less than previous standards. This difference was more significant in that only 73.9 percent of the derived labor standards reflects field time.

ACCURACY ANALYSIS OF NEW CROP LABOR STANDARDS

A representative farm (60 beef cows, 1,095 crop acres, 1.04 operators, 930 hired-labor hours, and 280 acres of custom wheat harvest as noted in Table 6) was formulated from the records of Farm Management Association, N.C. and S.C., cash crop dryland farms to test the accuracy of the new crop-labor standards.

Total operator labor was assumed to be 210 hours per man per month. That is probably too many hours, considering the number of good field work days available each month. Because only 73.9 percent of the new crop-labor standards reflects actual field time, then 155.2 hours of every 210 hours available must be spent in field operations. Given a 10-hour day, weather and soil moisture conditions would need to permit 15.5 days of every month for field work.

Operator and full-time hired labor available for crop enterprises is shown in Table 6. Using the new labor standards and monthly percentages, hours required each month to handle crop production on the representative farm were computed. The difference between "hours required" and those "available" are shown as deficit labor hours.

If crop labor standards represent actual field conditions, then the total crop labor used to handle production on a given farm must be similar to the labor required as computed from the labor standards. Using the new labor standards, total deficit operator and full-time hired labor hours were 425, or a 5-hour surplus with 430 hours of part-time hired labor available.

SUMMARY

The computerized machinery investment generator program only approximates labor and machine hours for the tilling, planting, and harvesting operations a crop requires. But the new crop-labor standards computed using the technique--4.35 to 21.09 percent below those previously used--compared favorably with labor used on the representative farm.

A total of 26.1 percent of the labor time was used for repairs, lubrication, accounting, management, etc. Undoubtedly, nonfield hours are influenced by size and type of farm operation, so the percentage likely would not be the same for different sized farms. Additional study of nonfield hours per crop acres is required.

Table 5. New (1989) and Previous Labor per Acre Standards for Indicated Crops Central Kansas

Crop Enterprise	New Standard (Hour)	Previous Standard* (Hour)	Change (%)
Wheat	1.70	1.80	- 5.28
Corn	2.56	2.76	- 7.20
Soybeans	1.91	2.19	-12.65
Grain Sorghum	1.80	2.28	-21.09
Oats	1.45	1.52	- 4.35
Sorghum Silage	4.92	5.40	- 9.11
Bromegrass Hay	1.74	2.14	-18.51
Alfalfa Hay	5.29	6.56	-19.43

John L. Kasper, Larry N. Langemeier, and Orlan H. Buller, "Labor Requirements of Central Kansas Crops", Contribution No. 587, Department of Agricultural Economics, Kansas State University, Manhattan, Kansas, 1975.

Table 6. Labor Requirements for a Representative Farm Using New Crop-Labor Standards, Central Kansas

Representative Farm*

Livestock (head):

Beef Cows	60.0

Labor available (hours):

Operator	2,600	(1.04 men)
Hired labor	500	
Part-time hired labor	430	

Crop (acres):

	Dryland
Wheat	575
Corn	15
Grain sorghum	205
Soybeans	55
Sorghum silage	25
Alfalfa hay	65
Summer fallow - Idle	155
Total crop acres	1,095

Custom harvest (acres):

Wheat	280

Month	Operator Labor Hours**	Hired Labor Employee Hours	Available Labor Hours	New Standards Hours Required	New Standards Deficit Hours
January	177	42	219	0	0
February	177	42	219	19	0
March	177	42	219	47	0
April	177	42	219	33	0
May	177	42	219	195	0
June	177	42	219	328	109
July	177	42	219	371	152
August	177	42	219	275	56
September	177	42	219	159	0
October	177	42	219	327	108
November	177	42	219	85	0
December	177	42	219	0	0
	Deficit labor hours				425
	Part-time labor hours available				430
	Surplus (deficit) labor hours				5

*Operator labor per man was assumed to be 210.0 hours per month. A year-round hired labor employee consisting of 500 hours was assumed, with 430 hours of part-time hired labor available. Part-time hired labor hours were calculated using a $6.00 per hour wage rate. Custom work for crops was assumed to be 90.0 percent of machine hire, with custom work allocated to wheat harvest.

**Beef cow labor requirements were removed from operator labor hours as follows: 8.0 hours per cow allocated evenly to each month (217 hours - 40 hours = 177 hours per month).

Appendix Table 1. Machinery Size and Operation per Acre for Winter Wheat
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Tandem disk	15 ft.	21 ft.	27 ft.	2.00	July
Spring tooth	24 ft.	28 ft.	34 ft.	1.00	Aug
				1.00	Sept
Anhydrous fertilizer	12 ft.	15 ft.	21 ft.	1.00	Aug
Drill/fertilizer	13 ft.	26 ft.	30 ft.	.70	Sept
				.30	Oct
Dry fertilizer spreader	25 ft.	25 ft.	25 ft.	.20	Feb
Combine, self-prop.	18 ft.	20 ft.	24 ft.	1.00	June
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		
Two trucks*	.34	.31	.29		June

*Hours per acre.

Appendix Table 2. Machinery Size and Operation per Acre for Corn
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	1.00	Nov
Tandem disk	15 ft.	21 ft.	27 ft.	1.00 1.00	March April
Anhydrous fertilizer	12 ft.	15 ft.	21 ft.	1.00	April
Planter	15 ft.	20 ft.	30 ft.	1.00	April
Bed shaper	17.5 ft.	22.5 ft.	32.5 ft.	1.00	April
Row cultivator	15 ft.	20 ft.	30 ft.	1.00	June
Combine	15 ft.	20 ft.	30 ft.	1.00	Oct
Two trucks*	.65	.55	.50		Oct
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Hours per acre.

Appendix Table 3. Machinery Size and Operation per Acre for Soybeans
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Offset disc	14 ft.	18 ft.	18 ft.	1.00	Oct
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	.50	Nov
Chisel	12 ft.	16 ft.	20 ft.	.20	Nov
Tandem disk	15 ft.	21 ft.	27 ft.	1.00	April
				.50	May
Planter	15 ft.	20 ft.	30 ft.	.60	May
				.40	June
Row cultivator	15 ft.	20 ft.	30 ft.	1.00	July
Combine, self-prop.	18 ft.	20 ft.	24 ft.	.11	Sept
				.72	Oct
				.17	Nov
Two trucks*	.05	.05	.04		Sept
	.36	.34	.30		Oct
	.09	.07	.07		Nov
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p	200 h.p.		

*Hours per acre.

Appendix Table 4. Machinery Size and Operation per Acre for Grain Sorghum
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Trash mulcher	11 ft.	14 ft.	16 ft.	.50	Nov
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	.50	March
Tandem disk	15 ft.	21 ft.	27 ft.	1.50	May
Planter/fertilizer	15 ft.	20 ft.	30 ft.	.40 .60	May June
Row cultivator	15 ft.	20 ft.	30 ft.	1.00	July
Combine, self-prop.	18 ft.	20 ft.	24 ft.	.80 .20	Oct Nov
Two trucks*	.40 .10	.37 .09	.30 .08		Oct Nov
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Hours per acre.

Appendix Table 5. Machinery Size and Operation per Acre for Oats
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	1.00	Nov
Tandem disk	15 ft.	21 ft.	27 ft.	1.50	March
Drill/fertilizer	13 ft.	26 ft.	30 ft.	1.00	March
Combine, self-prop.	18 ft.	20 ft.	24 ft.	1.00	June
Two trucks*	.34	.31	.29		June
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Hours per acre.

Appendix Table 6. Machinery Size and Operation per Acre for Sorghum Silage
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over	Months
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	.80	March
Chisel plow	12 ft.	16 ft.	20 ft.	.20	April
Tandem disk	15 ft.	21 ft.	27 ft.	1.00	April
Planter/fertilizer	15 ft.	20 ft.	30 ft.	1.00	May
Row cultivator	15 ft.	20 ft.	30 ft.	1.00	July
Silage cutter	6 ft.	6 ft.	6 ft.	1.00	Oct
Silage packer* (Small Tractor)	.72	.72	.72		Oct
Three 2-ton trucks	2.15	2.15	2.15		Oct
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Hours per acre.

Appendix Table 7. Machinery Size and Operation per Acre for Bromegrass Hay
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over*	Months
Tandem disk	15 ft.	21 ft.	27 ft.	.10 .10	July Aug
Drill/fertilizer	13 ft.	26 ft.	30 ft.	.10	Sept
Rake	14 ft.	14 ft.	16 ft.	1.00	June
Windrower	14 ft.			1.00	June
Swather, self-prop		14 ft.	16 ft.	1.00	June
Baler - PTO	14 ft.	14 ft.	16 ft.	1.00	June
Stacking operations**	1.20	.93	.78		June
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Times over for tillage operations pro-rated share over a ten-year period.

**Hours per acre.

Appendix Table 8. Machinery Size and Operation per Acre for Alfalfa Hay
Central Kansas, 1989

Machine	Machine Size: Small farm	Average farm	Large farm	Times over*	Months
Moldboard plow	7.5 ft.	9 ft.	10.5 ft.	.20	April
Tandem disk	15 ft.	21 ft.	27 ft.	.20	July
				.40	Aug
Drill/fertilizer	13 ft.	26 ft.	30 ft.	.20	Aug
Field cultivator	25 ft.	25 ft.	28 ft.	.20	June
Rake	14 ft.	14 ft.	16 ft.	1.00	May
				1.00	June
				.90	July
				.20	Sept
Windrower	14 ft.			1.00	May
				1.00	June
				.90	July
				.20	Sept
Swather, self-prop		14 ft.	16 ft.	1.00	May
				1.00	June
				.90	July
				.20	Sept
Baler - PTO	14 ft.	14 ft.	16 ft.	1.00	May
				1.00	June
				.90	July
				.20	Sept
Stacking operations**	1.20	.93	.78		May
	1.20	.93	.78		June
	1.08	.84	.70		July
	.23	.18	.13		Sept
Tractor	80 h.p.	120 h.p.	160 h.p.		
Tractor	120 h.p.	160 h.p.	200 h.p.		

*Times over for tillage operations represents pro-rated share over a 5-year period.

**Hours per acre.