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Rotary Disk Mower-Conditioners
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Rotary Disk Mower-Conditioners

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When considering the purchase of new hay harvesting equipment, many growers want to know which mower-conditioner is best suited to their harvest conditions—the standard cutterbar or the rotary disk. The purpose of this bulletin is to describe the engineering characteristics of rotary disk mower-conditioners and to provide an economic comparison of the rotary disk with the cutterbar mower-conditioner.

Rotary disk mowers use horizontally rotating disks with swinging knives to cut the hay crop. They are well known for their ability to cut through heavy crops at high forward speeds without plugging. Field roughness usually limits forward speed before cutting ability, even in heavy, fine-stemmed or damp crops. Rotary disk mowers may not be the best choice for all situations, however. Hay growers need to con-

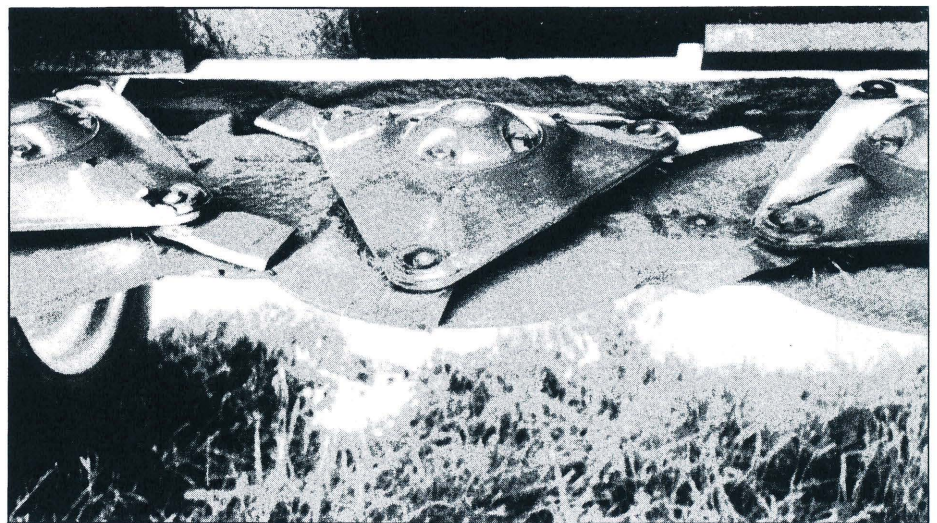
sider the specific needs of their operations and weigh those against the strengths, weaknesses and costs of the various types of mower-conditioners available.

ENGINEERING CHARACTERISTICS

Field Capacity

Rotary disk mowers have excellent cutting ability in all hay crops. In smooth fields, forward speeds of 8 mph or more are possible. Field capacities of 5 to 7 acres per hour are common with rotary disk mowers, compared with 3.5 to 4 acres per hour with a similar sized cutterbar mower.

Rotary cutting disk.



Power Requirements

A tractor with a 75 to 90 PTO horsepower rating is required to take full advantage of the added capacity of a 9- to 10-foot rotary disk mower-conditioner. A similar sized cutterbar mower-conditioner requires only about 45 PTO horsepower.

Repair and Maintenance

When the swinging knife on the cutting disk strikes a hard object, it pivots back beneath the disk. This helps prevent the need for minor repairs in situations where guard and knife section breakage and misalignment would occur with a cutterbar mower.

Field trials show that a set of rotary disk knives will typically cut 100 to 300 acres before needing replacement, depending on field conditions (2). Knife replacement time is about 1½ hours. Daily maintenance time is one-half hour to check gearbox and cutterbar oil levels and check grease fittings and belt tension.

Cutterbar mower repairs are fairly predictable and are usually neither expensive nor complicated. Rotary disk mowers, on the other hand, may not be as predictable. Some research has indicated that total accumulated repairs will be less for rotary disk mowers than for cutterbar mowers (5). But these reports are based on

information from a small number of machines, few of which had more than 1,000 hours' use. The power transmission system for rotary disk mowers is more complicated than that for the cutterbar mower, so it may be that cutterbar mowers require frequent minor repairs while rotary disk mowers require less frequent but more costly and complicated repairs. This question has not yet been fully answered.

Safety

Rotary cutting disks turn at about 3,000 rpm. The mowers are equipped with canvas shields in front of the cutterbar to catch debris that could be thrown by the mower. Objects thrown by the disks may still pose a risk to the operator, however. Stony fields or roadsides where glass, dirt or other debris is present may be particularly hazardous. For operator protection, a tractor with a cab should be used with rotary disk mowers.

Conditioning

Mechanical conditioners crimp, crush or abrade the stems of the hay crop to promote uniform drying of the leaves and stems. Uniform drying helps prevent excessive harvest losses that occur if the leaves are overly brittle when the stems are just ready for baling. Conditioned hay will be ready for baling one-half to one day

Table 1. Comparison of dry matter harvest losses with three mower-conditioners.

Mower type	Conditioner type	Mower-conditioner loss % total dry matter	Total losses % total dry matter
Cutterbar	Fluted rolls	3.89	7.50
Rotary disk	Fluted rolls	5.93	8.98
Rotary disk	Steel flails	7.25	10.95

Source: R. G. Koegel, et al., 1984.

sooner than unconditioned hay.

Rotary disk mowers and cutterbar mowers can be equipped with either roll-type conditioners or flail-type conditioners. Intermeshing rubber or nylon rolls crimp and crush the plant stems. Flail conditioners use rotating steel or rubber flails that abrade the waxy surface from the plant stem to speed drying. At least one manufacturer uses rotating steel fingers that pass between steel fingers on a stationary, adjustable comb. Most conditioners have two speeds to allow adjustment for crop conditions. The steel finger, stationary comb conditioner has 20 possible settings.

Recent research indicates no significant difference in field curing time between hay treated with intermeshing vs. flail-type conditioning units (1, 3). But use of the flail conditioner led to higher mower-conditioner dry matter losses, higher mower-conditioner and raking losses, and higher total harvest losses than use of the fluted roll conditioner.

Use of the cutterbar mower resulted in lower losses than use of the rotary disk mower when both were combined with the fluted roll conditioner. Highest losses occurred when the rotary disk mower was combined with the flail-type conditioner. With hay valued at \$65/ton, the value of dry matter lost per ton is \$4.88 with the cutterbar and fluted roll conditioner, \$5.84 with the rotary disk and fluted roll conditioner, and \$7.18 with the rotary disk mower and a steel flail conditioner.

If you use a chemical conditioner to help speed drying of your hay crop, the best results will be achieved with roll-type conditioners. Recent research at Michigan State University indicates more rapid drying when the chemical is applied in front of the roll-type conditioner (4). Apparently, the rolls help spread the chemical evenly over the hay as it passes through the rolls.

ECONOMICS

The increased field capacity and other benefits of the rotary disk mower-conditioner are not without a price. A rotary disk mower-conditioner costs \$1,500 to \$4,000 more than a similar sized cutterbar mower-conditioner. Also, a larger, more expensive tractor is required: 75 to 90 PTO horsepower for the rotary disk vs. 35 to 45 PTO horsepower for the cutterbar. These higher equipment costs place the rotary disk at an economic disadvantage under good to average operating conditions.

The higher ownership costs of the rotary disk mower-conditioners may be justified if you realize savings in labor costs and improved timeliness during the hay harvesting operation.

Labor costs on a per acre per year basis are lower—\$5.27 vs. \$6.12—for the rotary disk mower because of its higher ground speeds. It is unlikely, however, that enough acreage can be cut to recover the higher costs through labor savings alone.

Additional costs may be recovered if quicker mowing gets hay ready for baling quickly enough to avoid rain damage that would have occurred if mowing had taken longer and drying set back accordingly. You can improve the timeliness of the mowing operation by minimizing downtime for minor repairs and adjustments and increasing the number of acres mowed per hour. Rotary disk mowers may have a timeliness advantage in heavy crops, in tangled or lodged crops, and under rough field conditions. For the equipment considered in Table 2, the long-term increased value of the hay attributed to improved timeliness factors with a rotary disk mower must be at least \$4.75 per acre per cut (\$24.97-\$20.22) at the 50-acre level and \$1.34 per acre per cut (\$10.24-\$8.90) at the 150-acre level to justify the higher ownership costs of the rotary disk mower-conditioner (see Table 2).

The graph in Fig. 1 can be used to make a rough estimate of the cost of either mower-conditioner at various acreages. The graph can also be used to estimate the value of custom work for mowing and conditioning with either type of mower-conditioner. For a more accurate cost estimate under your specific conditions,

refer to worksheet No. 1, in north central regional Extension publication 214, "Estimating Owner's Costs."

EXAMPLE: You harvest 100 acres of alfalfa on a three cut per year system. A neighbor has 50 acres that he would like you to mow and

Table 2. Ownership and operating costs for two tractor/mower combinations under a three-cut system (cash flow basis, before tax costs).

CUTTERBAR MOWER-CONDITIONER

Acres grown	Tractor ^{1,2} ownership \$/acre/yr	Tractor ³ operating \$/acre/yr	Mower-cond. ^{4,5} ownership \$/acre/yr	Mower-cond. ³ operating \$/acre/yr	Labor ⁶ \$/acre/yr	Total \$/acre/yr	Total \$/acre/cut
25	16.60	1.86	88.52	.66	6.12	113.76	37.92
50	8.30	1.90	44.26	1.00	6.12	61.58	20.53
100	4.15	1.97	22.13	1.52	6.12	35.89	11.96
150	2.77	2.04	14.75	1.93	6.12	27.61	9.20

ROTARY DISK MOWER-CONDITIONER

Acres grown	Tractor ^{1,7} ownership \$/acre/yr	Tractor ³ operating \$/acre/yr	Mower-cond. ^{5,8} ownership \$/acre/yr	Mower-cond. ³ operating \$/acre/yr	Labor ⁹ \$/acre/yr	Total \$/acre/yr	Total \$/acre/cut
25	33.20	2.86	101.79	.42	5.27	143.54	47.85
50	16.60	2.92	50.90	.63	5.27	76.32	25.44
100	8.30	3.02	25.45	.96	5.27	43.00	14.33
150	5.53	3.12	16.97	1.23	5.27	32.12	10.71

¹One-eighth of the tractor ownership costs are charged to the mowing-conditioning operation.
Interest rate: 12 percent.
Insurance, shelter: 1 percent of initial cost.
Recovery period: 7 years.
100 percent financed.

²45 hp tractor, initial cost \$15,000.

³Accumulated repair and maintenance =
initial purchase price [RF1 (hrs use/1000)^{RF2}].
(Refer to ASAE Standard EP391.1)
Listed costs are distributed equally over 7 years.
Yearly fuel costs =
(fuel price) (0.05 gal/hp-hr) (rated PTO power) (hrs annual use).

⁴9 ft cutterbar, initial cost \$10,000.

⁵Interest rate: 12 percent.
Insurance and shelter: 1 percent of initial cost.
Recovery period: 7 years.
100 percent financed.

⁶\$6/worker-hr, ave. speed 4.5 mph, field efficiency = 0.80, 3.9 acres/hr.

⁷80 hp tractor with cab, initial cost \$30,000.

⁸9 ft 2 in cutterbar, initial cost \$11,500.

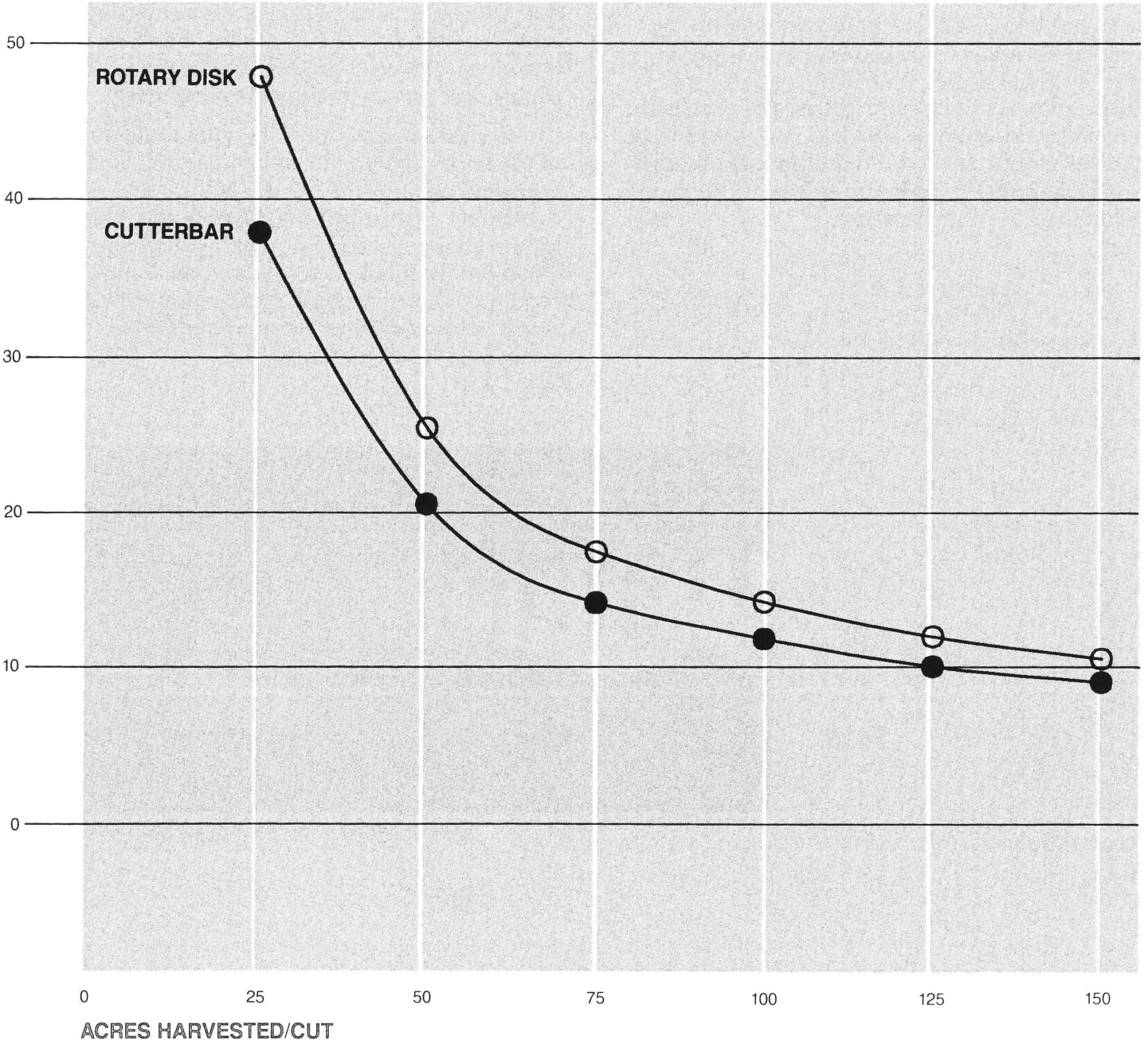
⁹\$6/worker-hr, ave. speed 6 mph, field efficiency = 0.80, 5.3 acres/hr.

MOWER-COCONDITIONERS COMPARED

Crop: alfalfa, 3 cuts/year

Activity: mow and condition

COST/ACRE/CUT



condition on a custom basis. What rate should you charge for your hay harvesting services?

ANSWER: Base your costs on 150 acres per cut. Enter the graph at the 150 acre per cut point on the horizontal axis. Move up vertically to the curved line for either the rotary disk or the cutterbar system. Then, move horizontally to the vertical axis indicating cost per acre per cut. Your costs are \$9.20 per acre per cut with the cutterbar and \$10.71 per acre per cut with the rotary disk. Add a 15 to 25 percent margin to cover profit and risk. With a 15 percent profit margin, you should charge \$10.60 per acre per cut with a cutterbar and \$12.30 per acre per cut with the rotary disk system. Additional charges may be required to bale and transport the hay and unload the bale wagons.

SUMMARY

Rotary disk mower-conditioners are capable of cutting heavy, fine-stemmed or damp hay crops without plugging at a rate of 6.5 acres per hour or more. They are durable enough to resist the need for repairs in most situations where guard and knife section breakage and misalignment would occur with a cutterbar mower. But the initial purchase price of a rotary disk mower is higher than that of a cutterbar, and a larger tractor is required to take full advantage of the rotary disk mower's added field capacity.

In fields where heavy, tangled or down crops are a problem, or under rough field conditions and on large acreages, some of the higher ownership costs may be recovered through lower labor costs and improved hay quality following more timely field operations. Caution is required when operating rotary disk mowers in stony fields and other areas where debris may be thrown by the cutting disks.



Rotary disk cutterbar with finger flail conditioner.



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