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# Evaluation Report 589


## Keho Wind Reel

A Co-operative Program Between
ALBERTA FARM MACHINERY RESEARCH CENTRE
PAMI
PRAIRIE AGRICULTURAL MACHINERY INSTITUTE

## KEHO WIND REEL

**MANUFACTURER AND DISTRIBUTOR:**

KEHO Alta Products Ltd.
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Barons, Alberta
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Telephone: (403) 757-2444

**RETAIL PRICE:**

$4085.00 [March, 1989, f.o.b. Humboldt, Saskatchewan, for the fan assembly, 24 ft (7.3 m) manifold and mounting hardware.]

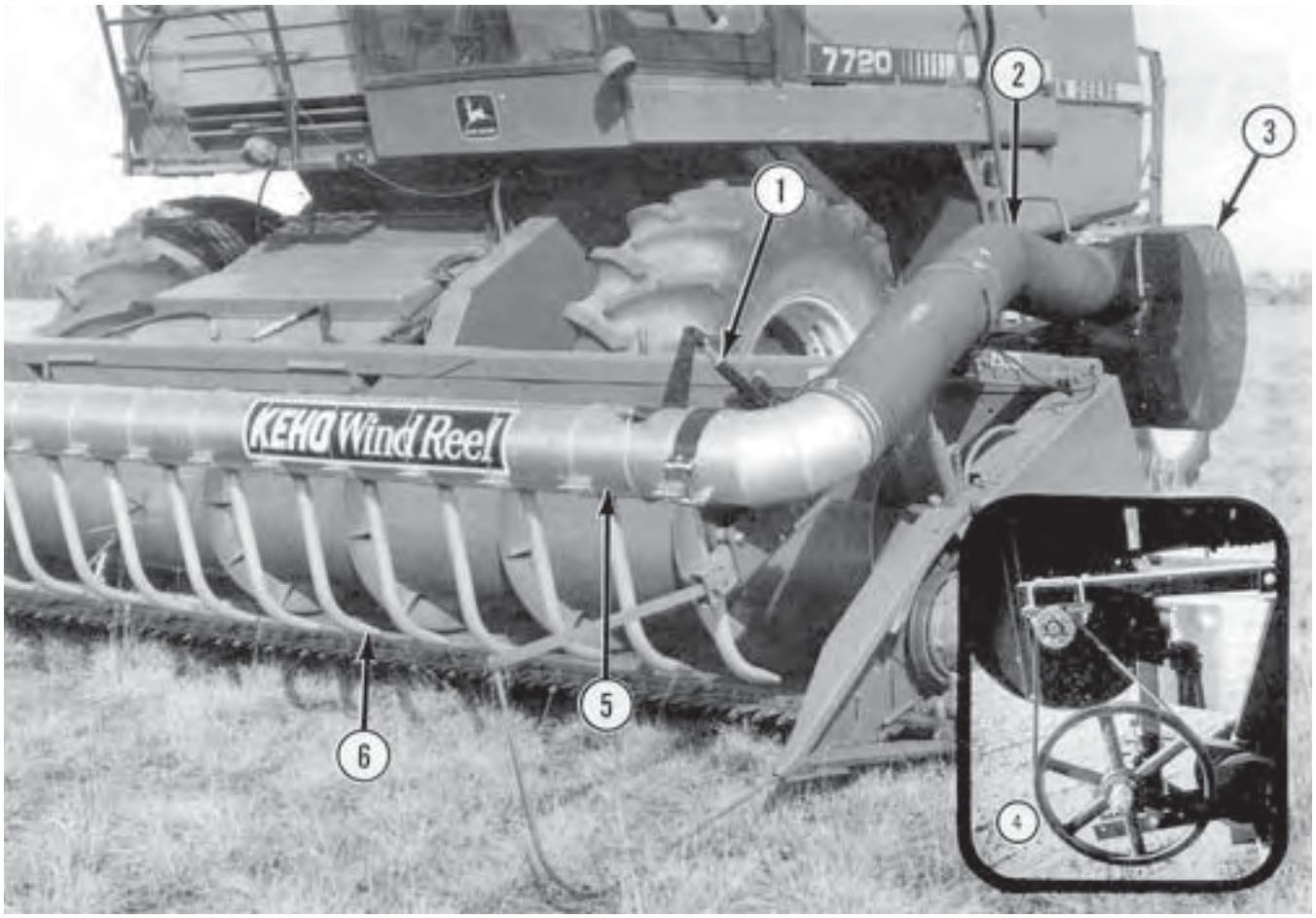


**FIGURE 1.** Keho Wind Reel: (1) Nozzle Tilt Actuator, (2) Flexible Duct, (3) Fan, (4) Fan Drive, (5) Manifold, (6) Nozzles.

## SUMMARY AND CONCLUSIONS

**Rate of Work:** The rate of work for the Keho Wind Reel was good. The reel did not limit combine speed in most crop conditions. Occasionally in tall heavy crops or in lodged, tangled crops, the feedrate had to be reduced to maintain smooth crop movement along and under the header table auger.

**Quality of Work:** The Wind Reel provided good air delivery to the crop. The volume, velocity, and distribution were adequate for most conditions encountered. Crop movement was good in most conditions encountered. Shatter loss and head loss were similar to those of a bat reel in average and taller crops. The Wind Reel was much better suited to operation in short crops than a bat reel.

**Ease of Operation and Adjustment:** The ease of installation of the Wind Reel was good once a keyway had been cut in the header shaft used to drive the fan. Ease of adjustment was good. Reel height and air discharge direction were adjustable from the cab. Ease of setting the reel to suit crop conditions was very good. The manual was helpful and adjustment caused noticeable change in performance. Appropriate settings were easily found for all crop conditions encountered. Visibility was very good in most conditions. Ease of maintenance was very good.

**Power Requirements:** The fan required up to 15.0 hp (11.2 kW). The power required to drive the fan did not noticeably affect the performance of the combine used in these tests.

**Operator's Manual:** The operator's manual was very good. It was well organized: complete and easy to use.

**Operator Safety**: No safety problems were encountered but normal caution was required.

**Mechanical History:** No mechanical failures occurred.

## RECOMMENDATIONS

It is recommended that the manufacturer consider:

1. Modifications to prevent straw and chaff buildup on the fan inlet.

*Senior Engineer: J. D. Wassermann*

*Project Manager: L. G. Hill*

## THE MANUFACTURER STATES THAT

With regard to recommendation number:

1. A redesigned inlet screen was tested by our company in 1988. It overcame the screen plugging problem. The new screen will be standard equipment in 1989. A self-cleaning rotary screen will also be available as an option.

## GENERAL DESCRIPTION

The Keho Wind Reel (FIGURE 1) uses jets of high velocity air to feed crop to a combine direct cut header. The air forces the crop back toward the header, as the cutterbar moves through the crop. Once the stems are cut, the air moves the crop to the combine table auger.

The air is supplied by a centrifugal fan and is ducted into a tubular manifold, which spans the width of the cutterbar. Vertical tubes (nozzles) spaced along the manifold direct jets of air at the crop.

The fan is mounted behind and slightly above the end of the header. It is belt driven from an existing header drive shaft and runs at a fixed speed. Air volume is controlled by an adjustable damper in the fan exhaust outlet. The manifold is mounted on the header reel arms. Manifold fore-and-aft position is manually set. Vertical reel position is adjusted on-the-go from the cab using the combine's reel height controller. An electric actuator, controlled from the cab, rotates the manifold to change the direction of the air blast from the nozzles.

Detailed specifications are given in APPENDIX I.

## SCOPE OF TEST

The main purpose of the test was to determine the functional performance of the Keho Wind Reel. Measurements and observations were made to evaluate the Wind Reel for rate of work, quality of work, ease of operation and adjustment, power requirements, operator safety, and the suitability of the operator's manual. Although extended durability testing was not done, any mechanical failures, which occurred during the test were recorded.

The reel was mounted on a John Deere 224 header, which had its cutterbar set in the mid-position. The Wind Reel was operated for 26 hours during which 310 ac (126 ha) of crop were harvested in various field conditions as shown in TABLE 1.

Gathering loss tests were conducted in both wheat and barley. Shatter loss (threshed kernels) and head loss were collected using "nested" pans placed across the width of cut. Several sets of collections were made at a single ground speed, which was typical for the combine. For comparison, similar collections were made under the same conditions at the same speed using a bat reel.

In the lab, tests were conducted to determine fan performance and also to define the air discharge pattern from the nozzles.

## RESULTS AND DISCUSSION

### RATE OF WORK

The rate of work for the Keho Wind Reel was good. The reel seldom limited harvesting rate in the conditions encountered.

In short, low yield crops, ground speeds up to 8 mph (12.9 km/h) were possible. However, at this speed the cut was ragged and the demand on the operator to control the header when operating so close to the ground made prolonged operation impractical. Speeds of 6 to 7 mph (9.7 to 11.3 km/h) were much more suitable. These speeds were generally 1 to 2 mph (1.6 to 3.2 km/h) faster than practical when using a bat reel. In the heavier crops, speed was usually limited by combine capacity and the header's conveying ability. Speeds were similar to those attained when using the bat reel. Occasionally, in these heavier crop conditions, the air did not provide enough force at the feeder to keep the crop going under the table auger; momentary bunching and "stalk first" feeding occurred. In lodged crop, forward speed had to be reduced to allow for feeding in bunches of crop.

### QUALITY OF WORK

**Air Delivery:** Air delivery was good.

Air was supplied by a Keho centrifugal fan. The fan typically delivered about 2200 cfm (1040 L/s) of air with the fan damper fully open. The static pressure in the manifold ranged from about 16 to 19.5 in•wg (3990 to 4860 Pa). The static pressure in the nozzle tubes varied by only about 6% from the average. The small differences in static pressure between the nozzles suggested fairly uniform airflow along the length of the manifold.

The air discharge pattern from the nozzles is shown by the smoke patterns in FIGURES 2 and 3. FIGURE 2 shows that, viewed from above, each nozzle discharged air in a "fan" shaped pattern. The discharge has two distinctly stronger jets of air at the outer edges of the pattern. These combined with jets from adjacent nozzles, approximately 6 in (15 mm) behind the nozzle tips, forming a larger single jet between the nozzles, which was directed straight back. The side view, (FIGURE 3), shows that the air blast from the nozzles is not very deep. The air spread only to about 4 in (102 mm) after it had travelled 10 to 12 in (254 to 305 mm). The air blast dispersed rapidly after travelling about 12 in (305 mm), but did maintain a distinct pattern up to 24 in (610 mm) behind the nozzles. Although the lab test showed considerable variation in airflow across each discharge pattern, in the field there were no definite signs, which indicated a more uniform pattern was needed.

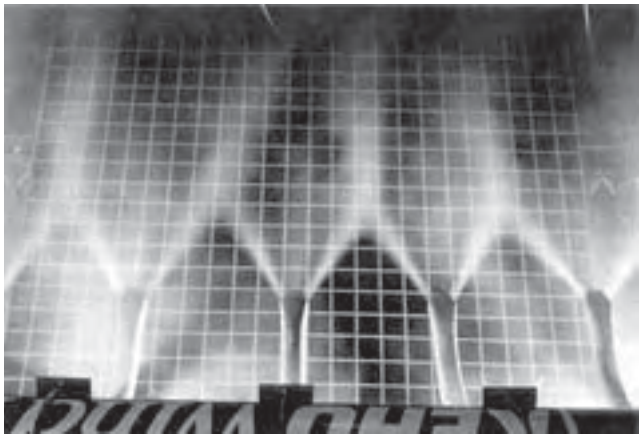

**FIGURE 2.** Top View of the Nozzle Discharge Pattern.

**FIGURE 3.** Side View of the Nozzle Discharge Pattern.

The inlet on the fan was susceptible to plugging. In most conditions, it was not severe and had very little effect on performance. However, in dry barley, loose leaves and straws were sucked against the inlet screen (FIGURE 4) and built up until performance was adversely affected. The material had to be removed by hand. It is recommended that the manufacturer consider modifications to prevent straw and chaff build-up on the fan inlet.

**Crop Movement:** Crop movement was good.

When straight combining, a reel performs several functions critical to proper crop movement into the combine. First, it must hold the crop so that the cutterbar can move through the crop and cut the stalks. Next, it must ensure that the crop is moved back to the table auger correctly for proper conveying and feeding. In taller crops, the material should be transported vertically along the front of the table auger. The reel must prevent the plants from falling forward, which is especially important at the center where the crop accumulates before being fed under the auger. In shorter crops, the material is normally conveyed under the auger rather than in front of the auger. The reel must direct the plants to fall headfirst into the auger. This

**TABLE 1.** Operating Conditions

| Crop | Variety | Yield Range | | Crop Height | | Field Area | | Crop Harvested | | Hours |
|---|---|---|---|---|---|---|---|---|---|---|
| | | bu/ac | t/ha | in | mm | ac | ha | bu | t | |
| Barley | Harrington | 50 - 60 | 2.7 - 3.2 | 12 - 24 | 305 - 610 | 35 | 14.2 | 2000 | 43.6 | 5 |
| Wheat | Katepwa | 5 - 35 | 0.3 - 2.4 | 10 - 40 | 254 - 1016 | 275 | 111.3 | 3500 | 95.5 | 21 |
| Total | | | | | | 310 | 125.5 | 5500 | 139.1 | 26 |

is required to ensure headfirst conveying to the feeder. However, once under the auger, there is a natural tendency for the crop to spiral with the auger. To prevent this, most headers are equipped with “auger strippers”. This is an adjustable metal strip located on the header panel behind the auger. It is set at a minimal clearance to the auger flighting. This strips the crop from the auger, forcing the auger to convey the material to the center.

**FIGURE 4.** Straw and Chaff on the Fan Inlet.

The Keho Wind Reel, when properly adjusted, provided suitable crop movement in most crop conditions encountered. In typical crop stands, 20 to 30 in (510 to 760 mm) tall, the air blast held the crop for effective cutting and kept the crop travelling smoothly along the front of the auger (FIGURE 5). At the center, the crop was pulled under the auger and fed headfirst into the feeder. In taller crop, although crop flow was usually smooth, at higher feedrates or where crop leaned away, occasionally the cut crop would fall forward causing the standing crop to push away from of the cutterbar. This usually occurred either at the outer ends of the header or at the center. It is possible that slightly different manifold adjustment may have prevented this from occurring. However, because of the infrequent occurrence, the exact change that was required was not readily apparent. Once the pile of crop was blown in, a normal feedrate could be resumed.

**FIGURE 5.** Typical Crop Movement.

In shorter crops, 10 to 15 in (250 to 380 mm) tall, the air blast worked well for holding the crop while being cut and it moved the crop smoothly over the cutterbar. However, since the crop was very shod, it was conveyed under the table auger. Once under the table auger, the typical tendency of an auger to carry material around with it resulted in most of the crop being conveyed behind the auger against the “auger stripper”. On this header the “auger stripper” often did not hold the crop. Towards the center of the header, where more material was being conveyed, crop was carried around the auger and often thrown forward onto the ground. The air blast had little to do with the carry over and it is possible that this behavior was unique to this one header. To keep the crop contained, a second “auger stripper” was added. A small angle was bolted to the auger trough floor just slightly behind the auger’s vertical centerline. The “floor stripper” greatly improved this header’s crop conveying in the short crops encountered.

**Gathering Loss:** Gathering loss is made up of loose kernels and heads, which are lost during the gathering process. The loose grain is called shatter loss and is grain threshed by contact with the reel, table auger or auger fingers, and/or by the vibration created by cutting and crop movement. Head loss consists of whole or part heads which fall to the ground. These heads may be lost because the heads have dropped into the crop due to weakened straw, and the cutterbar cuts above them. Alternatively, the heads may be just above the cutterbar, and fall off the cutterbar as soon as they are cut. As well, some heads may be thrown forward by the auger or auger fingers.

When comparing two different reels it would be beneficial to be able to compare the loss from each reel. However, it is nearly impossible to collect only the loss that each reel caused. A more practical method is to compare the gathering loss from the same header alternately equipped with each reel and tested under similar conditions. Since the other components are the same, any differences in gathering loss can be attributed to the reels.

The wheat and barley crops used for the loss tests were mature, dry and of an average stand. The combine was operated at about 3 mph (4.8 km/h) in barley and at about 3.5 mph (5.6 km/h) in wheat. The shatter loss when using the Wind Reel was low. In barley, shatter loss was less than 0.5% of the yield and in wheat was about 0.3% of yield. These losses were nearly identical to those of the bat reel. Harvesting at slightly higher moisture contents would have likely even further reduced the shatter loss. Head loss was about 2 to 2.5% of yield in both wheat and barley, which was nearly identical to the head loss of the bat reel. Again, harvesting at higher moisture before the heads had settled into the crop would most likely have greatly reduced head loss.

Although gathering loss for the Keho Wind Reel was not significantly different than the bat reel in average crop conditions, different results could occur in other crop conditions. However, there are simply too many combinations of speed, equipment selection and crop conditions to provide a complete comparison. Nevertheless, general observations were used to qualitatively assess losses in more extreme conditions. In short crop, the constant air blast continually moved heads and short crop over the cutterbar and into the auger. On some headers, a reel bat may not have been able to clean the cutterbar. In such a case, the cut crop would have dropped onto the cutterbar, with a large percentage falling to the ground. Whereas, with the Wind Reel very little crop fell off the cutterbar.

## EASE OF OPERATION AND ADJUSTMENT

**Installation:** Ease of installation was good.

Once a keyway was milled in the left header shaft, it took two people approximately another four hours to assemble and mount the Wind Reel on a John Deere 224 direct cut header. The fan assembly was mounted on the left end of the header (FIGURE 1). The fan mounting bracket was welded to the top beam on the header. The support tensioning bracket was bolted to the back header panel. Care was required to ensure belt alignment.

The nozzles were clamped to the manifold and the manifold attached to reel arm brackets. These brackets were clamped to the reel arm with U-bolts. The manifold was light and easy to handle. The flexible duct with its tube insert was easy to assemble and install. The electric actuator for rotating the manifold was easy to install and the wiring harness was appropriate.

**Adjustment:** Ease of adjustment was good. Moving the reel fore-and-aft was quite easy, although loosening and tightening the U-bolts was inconvenient.

Nozzle angle adjustment was very easy using the electric actuator to rotate the manifold. The actuator was controlled by a switch in the cab and could be adjusted on-the-go.

The fan damper control lever was located on the top of the fan discharge. It was easy to adjust; however, adjustment required getting out of the cab, which was inconvenient. The optional damper cable control would have been useful. Reel height adjustment was easy using the combine’s reel height controls.

**Field Setting:** Ease of setting for crop conditions was very good.

The operator’s manual provided basic information, and change in settings provided very noticeable differences in performance. The clear feedback enabled quick and easy establishment of appropriate settings for particular crop conditions. Once an appropriate setting

was found for a particular crop condition, the Wind Reel was able to handle considerable variation in plant population, forward speed, and differences in crop height across the header without additional adjustment.

In average crops, where 16 to 24 in (410 to 610 mm) was being cut, the nozzles were typically set at head level, 12 to 18 in (300 to 460 mm) ahead of the cutterbar and pointed at the cutterbar (FIGURE 5). The fan damper was usually set at three-quarters to fully open.

In taller crops, the nozzles were aimed further back in order to apply the air blast to the upper part of the plant (FIGURE 6). However in crop, which leaned away from the combine the nozzles had to be lowered into the crop (FIGURE 7) to prevent crop from "pushing" forward, especially at the center of the header.

In lodged, tangled crop, the nozzles were lowered close to the crop mat with the air blast directed towards the cutterbar (FIGURE 8).

**FIGURE 6.** Settings for Taller Crops.

**FIGURE 7.** Settings for Leaning Away Crops.

**FIGURE 8.** Settings for Lodged Crops.

Alternatively, if the reel was located quite far forward when the nozzles were lowered, the air blast could be aimed almost parallel to the ground. In short thin crops, the nozzles had to be run quite low and pointed at the cutterbar (FIGURE 9).

**Visibility:** The Keho Wind Reel enabled very good visibility of the crop, cutterbar and header in most crop conditions.

In short sparse crops, the constant airflow kept the cutterbar clean, while in all crops the manifold and nozzles obstructed the operator's view very little. The Wind Reel stirred up more chaff and dust than with a bat reel. This was not a problem except in the dim light between sunset and dark. At this time of day the chaff and dust became much more noticeable. The decreased visibility was especially noticeable when operating in short crops where header height control was critical. During this hour or two, the natural light wasn't adequate to be able to see the ground and cutterbar, and the combine lights didn't make an appreciable difference. It was helpful to reduce airflow to as low as practical. Once dark, the combines lights were much more effective. The light penetrated the dust and chaff and visibility was greatly improved and normal airflow settings could be used.


**FIGURE 9.** Settings for Sparse or Short Crops.

The Wind Reel was less tiring to operate especially at night due to the absence of intermittent light reflection typically experienced with a bat reel.

**Maintenance:** Ease of routine maintenance was very good.

Very little maintenance was required. The drive belts seldom required tensioning and the bearings required lubrication only at about 150 hour intervals. Adjusting the belt tension was not difficult. However, the drive shield was inconvenient to remove, as it had to be unbolted. While the belts from the header shaft to the jackshaft could be adjusted without affecting the drive to the fan, the reverse was not true. Therefore, if the fan drive was adjusted, the drive from the header shaft also had to be readjusted. This was inconvenient.

Occasionally, it was necessary to remove the manifold end cap to enable chaff and dirt in the tube to be blown out.

## POWER REQUIREMENTS

Power requirements for the Keho fan ranged from 12.5 hp (9.3 kW) with the damper closed, to 15.0 hp (11.2 kW) with the damper open. The fan drive handled the load without any problems and no adverse effects on combine performance were noticed.

The power required was higher than the power required by the bat reel. On combines, which operate near their power limit, the extra power required to run the fan may cause a slight reduction in the feedrates normally attained.

## OPERATOR'S MANUAL

The operator's manual was very good.

The operator's manual was easy to use and useful. It was well organized and well written. Explanation, instructions, and illustrations were clear and complete. The manual provided the necessary information on installation, operation, and maintenance.

## OPERATOR SAFETY

The Keho Wind Reel did not present any safety problems. The fan had one warning decal and the operator's manual made specific note of safe operating procedures.

Any time when working near the header, it is vitally important to disengage all drives and shut off the engine. The header should be lowered to the ground or securely blocked.

## MECHANICAL HISTORY

No failures occurred during the test.

## APPENDIX I
## SPECIFICATIONS

| | |
|---|---|
| **MAKE:** | KEHO |
| **MODEL:** | Wind Reel 24 ft (7.4 m) |
| **FAN:** | |
| -- type | centrifugal - backward curve blades |
| -- number of blades | 8 |
| -- outside diameter | 15 in (384 mm) |
| -- inlet diameter | 9.5 in (241 mm) |
| -- outlet diameter | 8 in (203 mm) |
| -- operating speeds | run at 5600 rpm (maximum 5900 rpm) |
| -- damper control | lever on fan |
| -- drive | 2 stage V-belt<br>3 “5vx” belts from header shaft to jackshaft<br>2 “3v” belts from jackshaft to fan |
| **MANIFOLD:** | |
| -- material | aluminum |
| -- thickness | 0.08 in (2 mm) |
| -- cross section shape | 8 in (203 mm) round, single section tube |
| -- length | 24.3 ft (7.4 m) |
| -- inlet diameter | 8 in (203 mm) |
| -- angle adjust | electric actuator |
| **NOZZLES:** | |
| -- type | single, curved aluminum tube with crimped outlet |
| -- number | 29 |
| -- length | 21 in (540 mm) |
| -- diameter | 15 in (38 mm) |
| **COUPLER:** | |
| -- type | flexible rubberized fabric with spiral steel reinforcing wire plus an aluminum tube insert |
| -- diameter | 8 in (203 mm) |
| -- length | 6 ft (1.8 m) plus 3.5 ft (1 m) aluminum tube |
| -- adapter to manifold | steel elbow |
| -- retainers | hose clamps |
| **WEIGHTS:** | |
| -- fan assembly | 160 lb (72.1 kg) |
| -- manifold and nozzles | 142 lb (64.3 kg) |
| **OPTIONS:** | cable control for fan damper |

## APPENDIX II
## MACHINE RATINGS

The following rating scale is used in PAMI Evaluation Reports:

| | |
|---|---|
| Excellent | Fair |
| Very Good | Poor |
| Good | Unsatisfactory |

## SUMMARY CHART
# KEHO WIND REEL

| | |
|---|---|
| **RETAIL PRICE** | $4,085.00 (March, 1989, f.o.b. Humboldt, Sask.) |
| **RATE OF WORK** | **Good;** seldom limited combine speed |
| **QUALITY OF WORK** | |
| Air Delivery | **Good;** uniform over length of manifold, fan pattern from each nozzle somewhat uneven |
| Crop Movement | **Good;** proper crop movement in most crops |
| Gathering Loss | similar to bat reel in average crops; lower head loss in very short crops |
| **EASE OF OPERATION AND ADJUSTMENT** | |
| Installation | **Good;** manifold light, all hardware appropriate, header shaft needed key way milled |
| Adjustment | **Good;** nozzle tilt and height from cab, optional damper control would be useful |
| Field Setting | **Very Good;** appropriate settings were easily determined |
| Visibility | **Very Good**; little obstruction, no intermittent reflection at night |
| Maintenance | **Very Good;** very little service required |
| **POWER REQUIREMENTS** | up to 15.0 hp (11.2 kW) |
| **OPERATOR'S MANUAL** | **Very Good;** well written and useful |
| **SAFETY** | normal caution required |
| **MECHANICAL HISTORY** | no failures |


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