PROGRESS REPORT

Project: SWATHER ATTACHMENT FOR SNOW MANAGEMENT

by

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FROM: Department of Agricultural Engineering
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The enclosed material summarizes the work undertaken and the results obtained to date in connection with the contract "DESIGN, DEVELOPMENT AND EVALUATION OF A SWATHER ATTACHMENT FOR SNOW MANAGEMENT": Contract Serial Number O8Z79-00103, DDS File Number 07SZ.01843-9-0916.

Respectfully submitted,

[Signature]
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September 24, 1979
SWATHER ATTACHMENT FOR SNOW MANAGEMENT

OBJECTIVE

To design, develop and evaluate an attachment on a self-propelled swather to leave a narrow strip of tall stubble for snow trapping purposes.

REVIEW OF PROGRESS

Progress has generally followed the tentative work plan outlined in the project proposal (attached Appendix A). That is, initial concepts for design and direction of the mechanical phase were undertaken by Mr. Del Erickson, Senior Research Engineer (also a grain farmer). This informal report is appended as Appendix B. His work was followed by that of Mr. Robert D. Wilson, Research Engineer, who added more thought to design and began work on fabrication of various models. It should be noted that Dr. Ben Dyck, Research Scientist, C.D.A. Swift Current Research Station, gave very valuable assistance and insights during this phase. In fact, Dr. Dyck originally provided the inventive idea of using a deflector type attachment mounted directly on the swather cutter-bar.

Model fabrications of the deflector-type attachment proceeded with the objective of testing them during the harvest of a winter wheat or fall rye crop. A used, self-propelled (IH 175) swather was purchased and fitted with deflectors. Unfortunately, the late spring had delayed crop development and harvest until the end of July, which, because of a warm sunny summer, preceded harvest of spring-sown crops by only 2-3 weeks. These field tests with the deflectors were not too encouraging. A combination of rough field conditions and operation in a tall, thin-stemmed crop resulted in snow-trap strips consisting of too many bent and lodged grain stems which were left both unharvested and ineffective as a snow-trap. However, because of their simplicity, deflectors were not dismissed.

Prior to field testing of the deflectors, fabrication of a side-mounted clipper had also begun. This unit consisted of a short but separate cutter-bar, a reel and a conveyor and was ready for initial field testing by the 16th of
August. Subsequent adjustments and modifications demonstrated that this clipper could leave a generally satisfactory strip of tall wheat stubble. However, field testing also showed that perhaps a new concept in design could perform even better.

Field tests with deflectors were again initiated for the harvest of spring wheat. After considerable adjustment and change in configuration, the deflectors were leaving fairly satisfactory snow-trap strips, except when the swather was turned sharply. It appeared that deflector width and swather speed had to be adjusted for crop height and wind direction. Nevertheless, final deflector field testing proved very encouraging.

Various tall stubble strips were left for over-winter snow-trap testing on three fields at two locations. Three types of trap-strips were to be evaluated on the University of Saskatchewan, Kernen Farm and on the private farm belonging to Mr. Gerry Kernen. Both test fields had been spring-seeded to red wheat and are located near Saskatoon. In addition, approximately 6 hectares (15 acres) of durum wheat were swathed leaving deflector-made, snow-trap strips on the farm of Mr. Earl Wise near Eston, Saskatchewan. Arrangements were also made to establish test-strips on a farm near Humboldt, Saskatchewan. At this date, actual establishment at the latter location is not confirmed. Soil and water testing at these locations will progress as planned.

Plans have been adjusted to also continue mechanical development of a new design concept for a swather attachment. Although the original work plan does not include this work, the possibilities of developing a better unit would seem to justify its support. The new design-concept could perhaps more accurately be referred to as a swather modification with limited attachments. Details of the concept are still under review and change; thus, they are not included in this report.
MECHANICAL DESIGN AND DEVELOPMENT

R.D. Wilson

Two main types of attachments were considered: (1) a deflector mounted on and forward of the cutter-bar, and (2) a power-driven clipper to cut and deposit the seed heads within the windrowed swath.

Deflector

Specifications

1) simple and maintenance free
2) readily adjustable to any position on the swather table
3) variable to any width
4) must not interfere with the ease of swather operation
5) must not cause considerable loss of grain
6) suitable to any make of swather
7) must not affect the quality of work done by the swather (i.e. swath bunching)
8) easily mounted and removed

Background

The main purpose of the deflector would be to force the crop plants to lean over so that the cutter-bar would cut through the stalk at a point above the normal cutting height. The longer stubble would then stand up as the swather moved past. The resulting trap-strip would look as in Figure 1.

The deflector would be bolted on the swather table at the holes for the cutter-bar guards. This would allow for attachment at any point across the swather width on any make of swather. This would also allow for easy width adjustment or removal of the deflector when not needed.

An average crop height of 700 mm and an average stubble height of 200 mm were assumed. From that, it was suggested that one side of the deflector should be 400 mm wide. It was thought that that width would allow the straw to lean
Figure 1: Deflector Strip Profile.

Figure 2: Formation of Deflector Strip.
a maximum amount while still cutting off the seed heads (Figure 2). The deflector width would have to be adjusted to suit taller or shorter crops.

Establishment of the position of the trap-strip along the swather width is important. The strip must be positioned so that it is not run over by the swather wheels on that or a following round. It must also be placed so that it is not flattened by the combine wheels. Placing the strip at the end of the table could cause problems the next time around with the swather. Care would have to be taken by the operator so that he does not cut any of the strip off or leave excessive standing grain beside the strip. Given these considerations, final placement of the strip would be determined by the type and size of swather and combine.

To insure that the crop flows along the edge of the deflector and not bend over, the deflector angle should not be too great. Field testing would determine the best angle to use. Canvas or rubber flaps attached to the reel batts may also aid in guiding the crop along the face of the deflector, lessen bending of the grain stems, and assist in moving the cut heads to the conveyor.

Field Testing

By the end of July, the first deflectors were ready for testing. On July 31 the swather was moved to the farm of Richard Saunders west of Saskatoon and the deflectors field-tested. Approximately 40 acres of fall rye was swathedi. The crop was very uneven, ranging from less than 500 mm to over 1200 mm in height. The field was very hilly with light sandy soil and an extremely rough soil surface.

The first deflector consisted of two 1¼" x ½" flat steel bars 200 mm long extending forward from the guard bolt holes and two 1½" x 1¾" x 1/8" angle iron extensions 800 mm long to function as faces with which the plant stems are deflected (Figure 3). Because of the rough, uneven terrain, the tip of the deflector was often forced into the ground. An addition was made to tilt the
**Figure 3**: Two-Way Deflector

- $1/4" \times 1/4"$ Flat Bar (200 mm Long)
- $1/4" \times 1/4" \times 1/8"$ Angle (800 mm Long)

**Figure 4**: Two One-Way Deflectors

- $1/4" \times 1/4" \times 1/8"$ Angle (650 mm Long)
- $1/4" \times 1/4" \times 1/8"$ Angle (500 mm Long)
tip of the deflector upward. A number of width and tilt variations were tried with the same result. The rye straw gave little resistance and instead of leaning sideways for a lengthened cut, the straw bent forward and went under-neath the cutter-bar. Different lengths and widths of both one-direction (either left or right) and two-direction (left and right) deflectors met the same fate. Lifter fingers were placed beside the deflectors on the cutter-bar guards to aid the crop being fed into the sickle bar. These appeared to provide little or no benefit.

Observations of these tests showed two things. Firstly, the straw was not stiff enough to lean past the deflectors without bending; as a result, most heads were left on the stalks uncut as the plants were bent and passed under the swather. Secondly, the length of future deflectors would need to be reduced. This would allow the reel to pull on the top of the plant passing it along the face of the deflector.

With these ideas in consideration, shorter deflectors of the same type were fabricated. It was hoped that the wheat straw would prove to be stiffer than the rye and lean more without bending. In August the following deflectors were tested at the Kernen Farm with these results:

a) Two lifter fingers were bent to form a V-shaped deflector. Total width was five cutter-bar sections (15 in = 380 mm). The result was a trap-strip, triangular in cross-section, with most or all seed heads cut off. Maximum strip height approached 500 mm.

b) Two pieces of 500 mm long angle iron were bolted to the flat bar exten-sions to form a V-shaped deflector (similar to the deflector described earlier). Total deflector width was five cutter-bar sections (15 in = 380 mm). The resulting strip was similar to that of (a).

c) Deflectors (a) and (b) were placed side by side with a two section (6 in = 152 mm) cutting gap between.
d) Two 800 mm long pieces of angle iron formed a V-shaped deflector. Total width was seven cutter-bar sections (21 in = 532 mm). The resulting strip was roughly triangular in cross-section with a few seed heads remaining. Maximum height of strip was near the crop height of 850–1000 mm.

e) The same deflector as (d) was positioned to a width of nine cutter-bar sections. The result was a strip containing many bent stalks with the seed heads remaining.

Deflector tests (d) and (e) used the same deflector that was used for fall rye. Resulting strips in wheat were much better than those in rye. The wheat straw was much stiffer. The smoother field and more even crop also aided in making a more desirable trap-strip.

f) Two single-directional deflector were placed on the cutter-bar with one open cutting section (76 mm) space between them as in Figure 4. Each deflector covered seven section widths (21 in = 532 mm). The resulting strip resulted in many seed heads remaining with the stems.

g) Deflectors similar to (f) but with 500 mm long angles as the deflector face and 400 mm long braces were tested. A gap of one or two sections was left between the two deflectors. Each deflector covered five cutter-bar sections (15 in = 380 mm). The resulting strip had a few seed heads remaining in a tall crop but left many heads in the shorter crop.

h) Deflectors similar to (g) but covering only four and a half sections each (13 in = 342 mm) were also tried (Figure 5). The strip left was slightly shorter than (g) but with fewer seed heads, especially in shorter crops. Remaining stubble reached a maximum height of about 450 mm.
FIGURE 5: CUTTER-BAR MOUNTED DEFLECTOR

(Scale: 1:4)
Sheet metal shields were made to fit over the guards behind these deflectors. The straw moved in such a manner that these were not needed.

With all types of deflectors, the reel had to be kept quite low to insure that the crop flowed past the deflector rather than be bent over. This meant frequent adjustments of the reel height in uneven crop. Also, ground speed had to be slightly reduced. A speed greater than 4.5 mph (7 km/hr) caused the stems to bend over. Two possible methods of improving the flow of the crop past the deflector are:

1) installation of flexible batts on the swather reel to extend down farther into the crop as it passes along the deflector, and

2) change of the reel position and speed; perhaps a reel setting further ahead would help force the grain back along the deflector.

Positioning of the deflector along the swather front proved important. If the deflector was located too near the end of the swather table, care had to be taken so as not to cut the trap-strip off on the next pass.

Clipper

Specifications

1) The attachment must leave a strip of stubble of maximum height.

2) All seed heads must be cut and conveyed to the swath.

3) All heads must be placed in the swath in such a manner that combining losses are not increased.

4) Attachment must be adjustable to suit crop height, preferably from the driver's seat.

5) The attachment must not interfere with the ease and quality of swathing.

6) The attachment should be suited to fit any make of swather.

Two possible positions of mounting the clipper were investigated:

1) selective positions along the swather table width, and

2) at either end of the table.
Inside-Mounted Clipper

An attachment mounted somewhere across the width of the swather would eliminate one problem associated with an end-mounted clipper. That being, cutting part of the strip off or leaving standing grain on the succeeding pass.

The framework for this design would be supported by the swather reel and be free to rotate at the pivot point of the reel. The clipper would use the swather reel to feed the crop to an independent cutter-bar. This cutter-bar would be located above and in front of the main sickle. That would allow the grain head to be cut before the lower part of the grain stalk reached the main cutter-bar. A shield would be needed to cover the lower bar so that the stalk is not cut off. The tall stubble would then bend under the swather and spring back up as the swather moved forward.

After the seed heads were cut they could fall onto the swather table either directly or via a chute. Heads could also be carried by a separate conveyor belt to the swath opening and dumped onto the forming swath. Power to drive the conveyor belt could be taken from the reel shaft.

The cutter-bar of the clipper would be located at the same height as the lowest point of the reel's path. Therefore the reel diameter would have to be reduced at that point.

The biggest problem with this design would be driving the sickle bar. At first, it was thought that a pitman arm from the main sickle would work. This, however, would not because the distance between the two is always varying. Developing a drive from the reel shaft would also be difficult. The reel rotates at 35–50 rpm. The sickle bar moves at about 600 cycles per minute. The large increase in speed could not easily be obtained. Because of this problem in driving the sickle and the fact that permanent damage may be done to the swather reel, it was decided that an end-mounted attachment would be more desirable.
End-Mounted Clipper

A "mini-swather" would be attached to the end of the swather and supported on the reel arm. A separate reel would feed the crop into a narrow cutter-bar (300-400 mm). The seed heads would then be transported to the swath in one of four ways:

1) via a sheet-metal chute leading to the main swather draper;

2) via a powered conveyor belt collecting clipped heads and depositing them on the main swather draper;

3) a combination of (1) and (2) with a belt running back from the cutter-bar elevating the seed heads onto a sheet metal chute which would dump the heads onto the swather canvas;

4) via a belt running from the clipper and depositing the seed heads directly onto the laying swath.

Figure 6 is a flow chart of the grain head movement through the four routes. The idea of using only the chute to transfer the heads to the canvas was rejected. In short crops, the clipper would be cutting at such a low point that the chute would be at insufficient grade to carry the heads away from the cutter-bar. Therefore, it was decided that a powered unit was necessary. This would insure that the heads would be moved regardless of cutting position.

The next idea was to have a conveyor belt running back away from the cutter-bar. The heads would be elevated above the reel arm by this belt and then dumped into a chute which would deposit them sideways onto the main canvas. This design would be the best for adaptation to any make of swather. However, due to the design of the IH 175, which was the swather available for modification, this was unnecessary. It was possible to remove the shield at the right end of the swather and install a conveyor belt running sideways (perpendicular to the direction of swather travel) under the reel arm. Because of the simplicity of this design it was preferred over carrying the heads on a conveyor belt
Figure 6: Flow Chart of Grain Movement Through the Four Clipper Types.
directly to the swath.

One problem that could arise when dumping onto the swather draper is the placement of the heads in the swath. The heads are dumped on the draper at the far right. It was thought that perhaps all the other grain would fall on top of it. To try to avoid this, the heads would have to be placed at the back of the canvas. This perhaps would allow the short heads to fall last and land on top of the swath.

The end-clipper design also allows the clipper to be put on or removed from the swather without making any major changes to the swather itself. This allows the farmer the option of easily changing between swathing with or without the attachment.

**Description of the End Clipper**

The chosen design is a "mini-swather" attached to the right end of the self-propelled IH 175 swather. The entire unit is attached to the swather reel arm and moves up and down as the reel arm moves. The mini-cutter-bar is suspended below the reel arm in a fixed position with respect to the clipper reel.

As the windrower passes through the crop, the clipper cutter-bar passes at approximately the same height as the bottom of the rotating main reel. This allows the top 150–200 mm of the crop to be cut, depending on the position of the swather reel.

The width of the clipper cut is 5 sections (15 in - 380 mm). A 305 mm (12 in) wide rubberized canvas conveyor belt carries the clipped heads sideways under the reel arm and dumps them onto the back portion of the swather canvas. The crop is to be fed into the clipper sickle by a four-batt reel, 340 mm wide and 550 mm diameter. The reel is powered by a V-belt running from a pulley on the shaft of the main reel. A 5-inch driving pulley and 3-inch driven pulley increases the rotational speed of the clipper reel.

The drive to move the sickle bar and the conveyor belt was brought from
the drive sheave of the swather canvas. A shaft was connected from the drive pulley and extended to the right end of the swather. This shaft is located on the rotational axis of the swather header. A V-belt at the right end of this shaft transfers power to a double pulley at the pivot point of the reel arm. A V-belt from the other half of this pulley runs downward and makes a 1/4 turn onto a sheave. This sheave is on a shaft that rotates acting as both the conveyor belt drive, and, via a crank, drives the cutter-bar. A pitman arm connected to this crank runs under the sickle to the opposite end where it connects to the sickle.

The cutter-bar on the main swather is driven by the same shaft that drives the clipper. Therefore, by keeping pulley sizes the same, the sickles of the swather and the clipper operate at the same speed.

The small conveyor belt, however, operates at a slower speed than the main canvases. The difference in speed results from a V-belt pulley arrangement which increases the drive speed to the main canvases. This speed increase was not built into the clipper. The slower speed of the clipper conveyor, however, caused no problems.

Mounting of the swather takes two men about fifteen minutes with a few common tools. One man can also do it alone. A few bolts clamp the unit to the reel arm, while bracing for the driving shaft bolts onto the header.

When the clipper is dismounted, operation of the original swather is not affected. The only permanent alterations to the swather are a few bolt holes in the reel arm and the header and a pulley welded onto the end of the reel shaft.

In order to mount the attachment a few temporary alterations to the right side of the swather had to be made. A sheet metal shield on the end of the swather was removed. A flat bar running diagonally across the end was taken off. And a section of copper hydraulic pipe that ran along the flat bar was replaced with a flexible rubber hose.
Field Evaluation

The completed model was tested the 16th of August in the harvest of spring wheat at the University Kernen Farm. Four problems were noted at that time:

1) some cut material was carried out over the back of the machine;
2) the cut material came onto the swather canvas in bunches;
3) the machine vibrated severely at high operating speeds;
4) thin strips of uncut grain stalks were left standing between the main cutter-bar and the clipper cutter-bar.

Modifications were made to the attachment to lessen these problems. The reel was raised 2½ inches. This reduced the amount of stalks flying out behind. In longer crops, when the main reel was too low the clipper was cutting longer pieces, some material still flew out the back. Two extra batts were added to the reel. A more even flow of material through the clipper resulted. Bunching of material through the clipper was eliminated. A counterbalance weight was added to the pitman crank to lessen the vibration of the clipper. The vibration problem was lessened but not corrected. A sheet metal shield was attached to the left side of the clipper. Most heads were directed into the cutting width of the sickle. A few stalks, however, still managed to get through.

Following these modifications, the final testing took place at the end of August. The clipper performed very well in cutting the top part of the wheat stalk and conveying it to the swath. Vibration of the unit at high operating speeds was still a major problem. After observing the vibration, a bracing bar was removed. The result was a great reduction in vibration. The bar that was removed had run from the pivot pin to the clipper frame. Obviously this bar was acting more like a spring than a brace.

The conveyor belt placed the heads in the central-rear region of the canvas at the extreme right end. The majority of the heads ended on the top of the swath and on the side closest to the clipper. Occasionally these heads rolled
off the swath and lay beside it:

A number of shorter heads were found lying on the ground in the strip. These heads had fallen through the knife. This problem was severe in very short crops when the clipper knife and conveyor belt was tipped ahead. Rubber flaps were added to two of the bats on the reel to clean material back from the guards. Head loss in very short crops was greatly reduced and virtually eliminated in taller grain.

In severely wild oat infested grain, some oat stalks cut by the main cutter-bar fell backwards and became entangled in and around the clipper conveyor belt and rollers. This caused the belt to stop rolling twice within a 30 minute period. It is suggested that the arms supporting the left belt roller be shortened. Wear on the edge of the conveyor belt was also noted.

Other than the wild oat tangles, the clipper performed very well. The only other stoppage was when one of the drive belts jumped off. The belt was replaced and no further problems occurred.

The clipper left a strip approximately 15 in (38 cm) wide every swather pass. Direction of travel was such that the clipper was on the inside of the crop front. With proper reel adjustment all or most heads were cut and transferred to the swath. A few stalks did pass between the swather sickle and the clipper sickle and were not cut. The operator had to be careful not to cut off any of the strip or leave any standing grain on the following pass.

In an even stand of grain the added clipper caused no extra work for the operator. In uneven crop, frequent reel height adjustments were necessary to insure maximum stubble height while collecting all the seed heads. A straw length of 150 mm flowed through the clipper very well, while there was some grain lost out the back of the clipper when the straw length exceeded 250 mm. Ground speed was about the same with or without the clipper attachment. Keeping the swather in a straight path was the operator's biggest problem. Leaving a
double clipper width every second swather pass was less of a task. This was
done by going back and forth across the field with the self-propelled swather. A
full double strip was rarely left but no standing uncut grain remained.
Appendix A

Proposal for Contract
under
Agricultural Engineering Research and Development (AERD)

Submitted by
Agricultural Engineering Department
University of Saskatchewan
Saskatoon, Saskatchewan
Swather Modifications for Stubble Management
to Conserve Water from Minimum Tillage

September 1978
Title: Swather Modifications for Stubble Management to Conserve Water from Minimum Tillage

Objectives:

This proposal outlines a program to design, develop and test a swather for simultaneous cutting of stubble at variable heights for optimum crop production from minimum tillage systems. The semi-arid climate of the Prairies dictates a need for such equipment, if reduced tillage is to result in adequate water for crops grown under continuous or extended seeding of stubble land. The Prairie snow resource has not been fully tapped for agricultural benefit and continues to await research into its engineered manipulation.

The basic objectives of this proposal are:

(1) To design and develop a swather modification to allow the cutting of a standing crop at selected, variable heights across the width of the cut.
(2) To evaluate the capability of the modified swather to leave an adequate stand of tall stubble sufficient to increase the conservation of winter precipitation under minimum tillage systems in prairie environments.
(3) To test the prototype with respect to mechanical performance (eg. cutting efficiency and distribution of seed heads to and within the swath) and its effect on grain recovery from the modified swath.

Background:

A major benefit resulting from reduced tillage has been an increase in the quantity of soil water available at the time of seeding (Lindwall, 1978). Winter weeds are controlled by herbicides rather than by tillage and the undisturbed crop stubble retains more of the snow carried across open fields by winter winds. The two effects complement and enhance winter water conservation.

Experiments at Swift Current, Saskatchewan have demonstrated the importance of adequate water to grow crops on the semi-arid Prairies (Staple and Lebane, 1952; Janzen et al, 1960). These tests indicated growing water requirements (spring storage in soil root zones plus summer precipitation) of 150 mm to sustain life in wheat plants and 250 mm to produce a base wheat crop at 1009 kg/ha (15 bu/acre). Each additional
25 mm of available water yielded an extra 201 to 336 kg/ha (3 to 5 bu/acre). The economic impact to Canadian agriculture which may accrue as the result of yield increases from soil water additions gained by stubble management under reduced tillage is obvious.

The merit of a tall stubble to efficiently trap snow is generally accepted and has been lauded by numerous investigators, including Willis et al (1969). Double swathing for combine efficiency has been adopted by some growers to cut the crop to alternate heights, one swathed low for placement of windrows and the second swathed high for snow retention. Three years of experiments by the Division of Hydrology, University of Saskatchewan, with the technique of leaving 30 cm wide strips of unharvested grain has shown promise in increasing snow accumulation between these strips. For example, with spacings of 1, 2 and 3 swather widths (one swather width equivalent to 5.5 m) with durum wheat, the maximum snowcover accumulation on the stripped plots averaged 18.6, 17.4 and 14.8 cm greater than the average depth retained by the non-striped stubble plots. These values represent increases of 88, 22 and 70%, respectively, for unharvested crop investments of about $12.35, $6.35 and $4.20 per ha ($5.00, $2.57 and $1.70 per acre). Snow manipulation by stubble management provides the greatest potential available to effect at least some control (short of irrigation) over the additional water required to grow adequate crops on stubble land under minimum tillage in extended rotations.

The practice of swathing a crop and leaving a narrow strip of tall stubble would appear attractive. Preliminary tests at the Goodale Farm, University of Saskatchewan, indicated that a 30-50 cm wide row of tall, but harvested, wheat stubble would trap additional snow in the magnitude of 50% greater than a conventional, low-cut stubble. It is believed that this management practice may be encouraged through the design and development of a swather which would function normally but also possess the capability to establishing a narrow section of tall, snow-trapping stubble.
References:


Work Plan:

It is expected the work will be conducted in three phases:

(1) The design, development and modification of the swather. At present several designs are under consideration. The physical problem of cutting the grain heads is relatively straight-forward. However, the design of an attachment which will most effectively and efficiently distribute them to the swath for subsequent separation has not been finalized. Obviously, if this can be achieved by simply emptying the heads directly onto the swather table, the design will be fairly simple. The system will be complicated, if an auxiliary conveyor system (pneumatic, belt or other) needs to be developed. One possible design involves the attachment of a one-metre long secondary cutting bar placed at an angle from the low conventional to the high cutting height. Estimated starting date is April 1, 1979 with a prototype constructed within 3-4 months.

(2) Functional testing of the modified swather. These tests will involve evaluation of mechanical performance, cutting efficiency and distribution of seed heads to and within the swath. Attention will be directed to such factors as power transfer,
material strength, structural aspects, adjustability, simplicity of swather modification, and mode of operation. Specific mechanical tests will be executed as time permits and judgement demands. This work will be initiated in July 1979 and extend over the 1979 harvest season.

(3) Field testing of swather performance.

Field trials will be initiated to evaluate total swather performance with respect to mechanical operation, laying of a suitable swath, grain recovery, and establishment of a functional stand of tall snow-trapping stubble. The modified swather will also be evaluated as to ease of handling, potential reliability, enhancement of losses in combined grain; if any, and successful execution of design function.

A total of about 32.5 ha (80 acres) of standing grain at two locations are planned for swathing with the modified implement. The resulting strips of tall stubble will be measured with respect to initial crop height, stubble heights, strip widths, and spacing across the field. The performance of each field swathed with the modified unit will be evaluated with respect to its snow-trapping efficiency. Snow surveys soil water sampling will be conducted on each field under with the cooperation of the Division of Hydrology, University of Saskatchewan. As such, no special equipment will be required. The results obtained, however, will also complement those obtained from a more comprehensive program and will serve several purposes. This phase of the work is scheduled for the harvest season of 1979 and the winter months of 1979-80.

A progress report of the project could be prepared by March 31, 1980. A final report, however, could not be made available before June 30, 1980, owing to the snow survey program which is scheduled to continue through April 1980.

Estimate of costs:

(1) Manpower (includes fringe benefits)

(a) Research Engineer or Technician (to be named)
   - participation in design, construction and all elements of the mechanical testing
   9 man months @ $1100/mo

$9,800.00
(b) D.E.L. Erickson (BE) or equivalent Research Engineer
-advirsory to design, fabrication and testing; in charge
of field testing for adequate snow accumulation and
data analysis
1.5 man months @ 1759.29/mo  
2,638.94

(c) D. Bayne, Research Technician
-assistance in test data collection and tabulation
2- man month @ 1290.04  
2,580.08

Sub Total  
15,019.02

(2) Equipment

(a) A swather must be obtained, either by rental from a
dealer at an estimated cost of 15% of equipment cost plus
shipping Est. Cost.  
2,500.00

(b) Component parts for swather modification
Est. Cost.  
2,000.00

Total Equipment  
4,500.00

(3) Equipment Rental

Computer costs for data analyses
12 hours on HP 2114B @ $25/h  
300.00

(4) Supplies:

(a) Telephone, xeroxing, printing, incidentals  
400.00

(b) Crop use for testing swather
80 acres (32.5 ha) @ $7.50/ha
Est. Cost.  
243.75

Total Supplies  
643.75

(5) Travel

(a) Transport of swather to test fields
and operation of the implement
60 hrs @ $5/hr
Estimated cost  
300.00

(b) Field trips and incidental travel
1200 km @ $.16/km

192.00

(6) Overhead charges

(a) 15% of 85% of items (1), (2), & (4)
15% of $17,138.35  
2,570.75

(b) 2% of items (3) & (5)
2% of $792.00  
15.84

(7) Supervision Services
Project Leader, Harold Steppuhn
Research Scientist
0.5 man months @ 2400/mo  
1,200.00

TOTAL  
$24,741.35
6. TERMS AND CONDITIONS:
   If this proposal is accepted, we agree to the inclusion of General Conditions DSS 1053 (8/74), a copy of which is now in our possession.

7. CONTRACTOR AND LOCATION:
   Department of Agricultural Engineering
   University of Saskatchewan

   Project Leader: H. Steppuhn (Ph.D., Research Scientist)
   Advisors: F.W. Bigsby (Prof. Agricultural Machinery)
             W.B. Reed (Head, Agricultural Machinery Research Section)
General Function (Deflector Type)
- during normal swathing operation, to leave a relatively wide swathed strip of standing stubble and grain for the purpose of trapping snow at

3

Crop Height

Normal Stubble Height

General Requirements
DEFLECTOR TYPE
- suited to any make of swather
- readily movable to any position on the swather table (PLAN T & T)
- must not interfere with ease of swathing operation, i.e., handling of mat, etc.
- must not cause clogging and loss of grain
- not for now
- preferably should be a cut-out from the tractor seat and that it can be moved, stopped if desired, e.g., if strips are not desired on every round
- should be easy to maintain
- adjustable in terms of width of strip left
- may also require attachment at a spot to plate on the underside of the swather to prevent canvas from damaging strip (PLAN T & T)
- must be quite light so that support is not a problem (aluminum).
mean and cal. class = 15 cm. from 11 near contact 10 cm. = 22 cm. stripper micrometer may be adjusted in other

- divide must be smooth to allow material to slide by with ease

- the angle that the bent arm stream will take relative to the cutting box will determine the shape of the strip for a given setting of the angled divider.

.60 cm.
GENERAL NOTES RE ADD-ON PULL CUTTER

- An outside mount on a corded and cordless type swather would create a problem with requiring a lot of room. Between the track right side of the track and the left end of the swather table, this type could work or on either end of a S.P. swather.
- If the reel or reel drive is used to drive the head clipper, a set of pulleys which would produce a large speed increase would be necessary.

- The simplest form of this type would be the attachment of a small Leader unit such as the K.E.M. plow bar unit on the right side of a S.P. swather (Zig-Zag), maintaining that no conveyer would be required for any of the possibilities, as could be fairly easy, by providing adequate support for the unit if attached to the reel arm. The unit could be driven either by the reel drive or by a small gasoline engine (for experimental purposes). The disadvantage of the engine would be excess cost and weight.

- If reel swather reel shaft is used to feed clipper reel, the head clipper knife must be placed forward of the main knife (inside mount only). The relative positions of the clipper knife (and reel) could be a problem (reel not far enough forward).

- The K.E.M. Leader appears simple enough to build what we need from materials.
REEL JUMPER SPECS.

REEL SPEED = 37.50 RPM
KNIFE SPEED = 580 CYCLES/ MIN

should provide similar speed for head clipper knife and reel

If head clipper knife is driven from main motor reel, then pulling size rather slow, be approx. 580 rpm (too much)

44

Use intermediate pulley set

REEL INTERMEDIATE KNIFE

\[ S_1 = 44 \text{ RPM} \]
\[ S_2 = 55 \]
\[ S_4 = 580 \text{ RPM} \]
\[ D_1 = 20'' \]
\[ D_4 = 6'' \]

\[ S_4 \approx 13 \frac{S_1}{D_2} = \frac{(13)(20)}{D_2} \]

\[ \frac{D_3}{D_2} = \frac{(13)(6)}{20} = 3.9 \]

\[ \text{If } D_2 = 6'', \text{ then } D_3 = 23.4'' \text{ (Reasonable)} \]
3) Outside Mount, No Conveyor

- Could probably mount a header, similar to the K.E.M. Abolé harvester on right-hand end of smut tires, far enough rearward that a conveyor would not be required. The lateral slide chute would still be required.

Slide Shute Top View

Clipper Knife

Clipper Reel

Main Conveyor

Reel Shaft

Belt Drive (One for reel, one for knife)
2) **INSIDE MOUNT**

**FRONT VIEW**

- **Conveyor Drive Belt to Rear Roller**
- **Knife Drive**
- **Eccentric Knife Drive**
- **Existing Reel Arm**
- **Rubberized Canvas Flaps**
- **Bearing Support**
- **Reel Shaft**
- **Adjustable**
- **Head Clipper Knife**
- **Front Conveyor Roller**
- **Divider**
- **Regular Knife**
- **Divider**

**TOP VIEW**

- **Support of this end of conveyor to could be to back of swather or reel or both**
- **Main Conveyor**
- **Reel Shaft**
- **Divider**
- **Pulleys**
- **Head Clipper Knife (more forward than regular knife)**
OUTSIDE MOUNT - SCHEMATIC

TOP VIEW

POLLEY TO DRIVE KNIFE AND ROLLER (SPEED PROBLEM - SEE CATER SHEET)
HEAD CLIPPER KNIFE AND
CONVEYOR ASSEMBLY SUPPORTED ON
REEL ARM. REINFORCEMENT OF REEL ARM
AND GREATER CAPACITY HYD RAM POSSIBLY REGD.
- mean to write again to the world.
  - he requires it to be cleared
  - concern of clipped heads toward the
  - trait of backward and therefore simply
  - disadvantage relative to outside type - narrower
  - width of cut.

- if conveyor clipped heads upward above near
  - of reel arm, then could drop them onto
  - slide chute to move them laterally to dryer...
Therefore, a slide will not work, loads must be conveyed to rear of draper.
General Functions

- To clip the heads off a strip of grain and deliver them to the swath, thereby leaving a strip of tall stubble.

General Requirements

- Mounted at right end of swather (pull type)

- Clip heads & deliver to rear of swather so that they will be deposited on top of swath.

- Adjustable in terms of height, width, and height of swather with respect to cutter bar.

- For test model, could be either powered by small gasoline engine or driven by reel drive. A side view might be adequate.

Problems (prior to swather)

- If mounted on tractor, there would have to be adequate room for swather swather and tractor to subsequent rounds.

Diagram: [Sketch of equipment]
REEL FLAPS

PLAN I

[Diagram showing a reel flap with dimensions and labels]

flap bolts onto reel bar
deflector

PLAN II

[Diagram showing another reel flap]

flap
deflector

PLAN III

[Diagram showing a third reel flap]

flap

very quick & easy to build
END OF SWATHER

- could actually increase operating width to 80 cm.
- the right end adjusting (and possibly shaft) must be adjustable or quickly interchange for ease when stripping is not desired.
- guide & swath should be adjustable (possibly a flexible rod) welded onto each guard as indicated
- the divider (C) could replace & attach in the same way, the original equipment on divider
- with the height of strip could be controlled by changing out a break of 1/2 inch (B) and
- the position of dividers (welded)
- each then could withstand the same lateral tension. To make and the squatting
LEAF STRIPES PLAN II

TOP

ALTERATE

MAY NEED RATE HERE

MOYABLE FINGERS

LIFTER

VARIABLE TO 90 cm.

90 cm.

LIFT FINGER

THIN ROD

X-SECTION A

POSSIBLY LOWER AT TIP

SIMILAR TO PLAN T RE: BOTTOM ATTACHMENT OF ARMS
The diagram illustrates a design for a leaf splitter. The descriptions suggest the creation of adjustable leaf splitting mechanisms with specific components and orientations. Here are the key elements:

- **Top View**
  - The diagram shows a top view of a setup with components labeled as follows:
    - **Lifter Finger**
    - **Alum. Square Tubing**
    - **Plate (top)**
    - **Plate (bottom)**
    - **Deflector (Pivoting)**
    - **Plate (bottom)**
    - **Lifter Finger**
    - **Hinged**
  - The setup includes a variable section that sets the width, W, to 2.04 (± 0.06)
  - The angle is set to 73°.

- **Bottom View**
  - The bottom view shows an alternative setup with labeled components:
    - **Support**
    - **Alum. Plate (bottom)**
    - **Plate (top)**
    - **Alum. Plate**
    - **Pivot (Bolt)**
    - **Smooth Edges**
    - **Alternates**

The diagrams also mention:

- **Thin Rod**
- **Same on both sides**
- **Tension**
- **Support**

The text suggests various adjustments and components for effective leaf splitting, focusing on precision and stability.