INTRODUCTION

Losses of grain in the field, which occur with the use of the header, combine and windrower, have caused much concern to farmers and research workers. Bracken (2) reported that the combine method of harvesting was more efficient than the header and thresher method. Hardy (5) stated that, since uniform maturity and low kernel moisture content were necessary for the straight combining of grain, a loss of grain could result from adverse weather conditions during the period between the binding and the straight combining stages. Many other research workers (4, 6, 7, 10, 11) suggested that the windrower should be used as a harvesting implement to reduce the losses caused by weather, green weeds or insects. Mayer (8) concluded that high threshing losses resulted because of the limited capacity of the combine cylinder. Nyborg (9) showed that the separating action of the straw walkers was the limiting factor in combine capacity, and that overloading this mechanism could contribute to a high harvest loss. It has been reported (1) that the pick-up loss may be minimized by operating the pick-up close to the ground as possible and by limiting the forward speed of the combine to four miles per hour.

Preliminary field studies with the windrower and combine were conducted at Swift Current in 1948 and 1949 to develop a technique for determining the grain losses, and to classify them. Two main groups of losses, natural and mechanical, were observed. The natural loss, which occurs prior to and during harvesting operations was caused by wind, rain, insects, animals and birds. The mechanical loss may be divided into three subgroups, namely, (a) the reel and cutter bar loss; (b) the pick-up loss; and (c) the loss caused by the threshing and separating mechanisms of the combine.

The purpose of this study was to determine the relationship between grain losses in the field at harvest time and plant maturity when harvesting by the windrower-combine method.

PROCEDURE

This study was performed in a field of Chinook wheat, and the sampling for the losses was carried out according to a randomized block design. Treatments, consisting of dates of windrowing, started when the grain was in the early dough stage, and continued on consecutive days, weather and field conditions permitting, until the grain was ripe. Eight replicates were used from 1961 to 1964, inclusive, and four replicates in 1965. Provision was made within each replicate for up to 20 dates of sampling, but the number of dates varied from year to year depending on the rate at which the grain matured. Each plot consisted of a 12-foot swath, cut with a self-propelled windrower, through the centre of an area 32 feet x 150 feet. The windrows were harvested with a combine equipped with a pickup when the moisture content reached 14.5 percent.

Four separate types of grain losses, measured by average weight in grams per square foot, were determined on each plot using the following procedure:

1. Natural loss: Eight square-foot collections of kernels and broken heads on the ground taken at random just prior to windrowing.

2. Reel and cutter bar loss: Eight square-foot collections of kernels and heads on the ground taken at random immediately after windrowing, minus the natural loss.

3. Pick-up loss: Eight square-foot collections of kernels and heads on the ground taken at random from the area on which the windrow had lain. The windrow, in most cases was four feet wide. The square-foot samples, which included the first two losses, represented a concentration of grain and short-stemmed heads from an area three times this width (i.e., a 12-foot swath). The pick-up loss was the square-foot collection minus the first two losses, divided by three.

4. The threshing and separating loss was determined by gleaning the loose grain, broken kernels and unthreshed heads of grain from the accumulation collected on a canvas at the rear of the combine over a distance of 50 feet of machine travel. This represented the loss in an area of 12 feet x 50 feet.

The data for the four separate losses were arranged in a descending order of kernel moisture content. A one percent decrement of moisture difference was used initially for this arrangement, but many gaps in the data were evident because the samples were not always taken on consecutive days and moisture differences varied from day to day. The number of gaps was reduced when a two percent decrement was used. The author resolved, as a result of observing the latter arrangement, that the grain losses in relation to kernel moisture content, could best be described by trends to provide a calculated loss for each two percent decrease in moisture. This was done by fitting a second degree polynomial, calculated by the method of least squares, to the data for each loss for each year. The individual calculated losses were then tabulated separately according to the moisture range they represented, and averaged. A second polynomial, of the same degree as the others, was fitted to this average figure to present a trend for each loss over the years under study. The range of the kernel moisture content was from 54 to 10 percent.

RESULTS AND DISCUSSION

The natural loss increased rapidly as the standing grain matured, and was the largest single grain loss in the field at harvest time (figure 1). This loss, which may be caused by weather conditions, insects, birds and animals, and affected by the inherent weakness to shattering of some varieties of wheat, may approach 100 percent of the potential yield.

The loss caused by the reel and by the cutter bar occurred when the grain was cut with the windrower or with the combine. The trend showed that this loss increased as the crop matured, but at a decreasing rate. This decrease in rate may be attributed to the loss of kernels which have already shattered from natural causes, leaving only those which were more firmly attached. The
The first combination of losses to be considered was the natural loss plus the reel and cutter bar loss. The combination may be regarded as a single loss applying to both the winnowing and straight combining of grain. The trend line for this combination showed that the rate of loss increased with advancing maturity of the grain, and that this loss could be very high when mature grain is straight combined.

The second combination of losses consisted of the pick-up loss added to the natural loss plus reel and cutter bar loss. The earliest suggested stage of maturity at which wheat can be windrowed is at 35 percent kernel moisture (3) (point A, figure 1). Grain losses at this stage exceed 1.0 bushels per acre. Later windrowing resulted in higher losses which approached 1.65 bushels per acre. An examination of the natural plus reel and cutter bar loss revealed that, for an equal loss (line B-C, figure 1), wheat should not be windrowed after the kernel moisture content reached 24 percent. Research (3) and experience have proved that the stage of maturity corresponding to 20 percent kernel moisture was a more realistic stage at which to stop windrowing and leave the crop for straight combining. The time element was important because the research (3) showed that there may be as many as seven days between the 35 and 20 percent kernel moisture stages, whereas the difference between the 20 and 14 percent stages may be only three days.

SUMMARY AND CONCLUSIONS

The loss of grain caused by natural elements was the largest single loss in a crop of wheat at harvest time. This loss increased rapidly as the standing grain matured and under adverse weather conditions may become very large.

The loss caused by the mechanical action of the reel and cutter bar of the windrower or combine also increased as the grain matured and, when added to the natural loss, the combination depicted what can be expected when wheat is straight combined. The advantage of early windrowing was also revealed, since both these losses were much smaller at a stage of maturity at which the kernel moisture content was 35 percent.

The pick-up loss, when added to the natural loss, and the reel and cutter bar loss, represented a grain loss common on most Western Canadian farms at harvest time. It would appear that windrowing after the kernel moisture content reached 20 percent was not advisable. Windrowing, after this stage of maturity, was an extra and unnecessary operation except where a rank growth of green weeds prevented straight combining, or in a field of lodged grain where uneven ripening was the problem.

REFERENCES


