Alfalfa Seed Harvesting

field studies of harvesting equipment and methods suggest means of improving seed germination

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Between one and two million pounds of viable alfalfa seed might be saved annually in California by proper adjustment and operation of presently used alfalfa harvesting equipment.

In field studies with 16 combine harvesters the average germination was increased by 10%, primarily as a result of adjustments of cylinder speed. If this percentage were applied to the 1949 state yield for all varieties of alfalfa seed—13,020,000 pounds of cleaned seed from 59,000 acres—the indicated saving would be 1,300,000 pounds of viable seed.

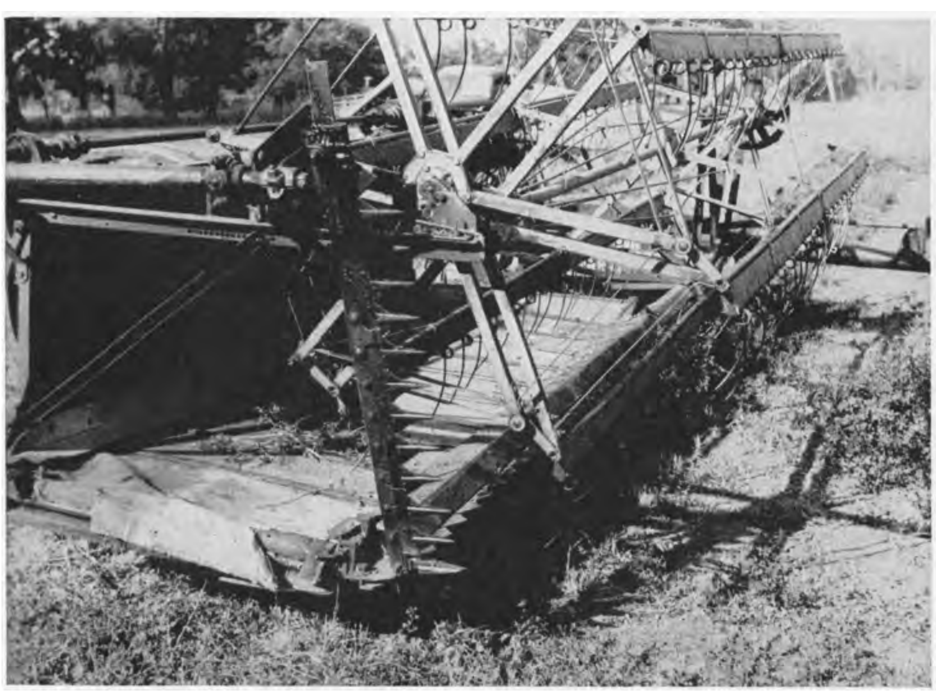
The combination of cylinder adjustments and other changes made during these studies reduced the average seed loss over the rear of the machine from 27 to 11 pounds per acre. This saving of 16 pounds per acre, if applied to the entire state acreage for 1949, would represent an additional saving of about 95,000 pounds of seed.

A high standard of germination—85% minimum—is required for certification by the California Crop Improvement Association. Each year a few lots of seed have failed to pass certification because of low germination.

Three new varieties of alfalfa—Ranger, Buffalo, and Atlantic—were approved for seed certification by the California Crop Improvement Association in 1945. Trial plantings were made and in 1947 the first appreciable quantity of certified alfalfa seed was shipped to the central and north central regions of the United States. By 1949 California's annual production of certified alfalfa seed had reached almost a million pounds.

In 1948, approximately 10% of the half million pounds of improved seed was in danger of rejection because of low germination. In some cases much good seed was lost in the careful screening required to remove broken seeds and bring the resulting germination up to an acceptable value.

Since mechanical damage seemed an important factor in the problem of low germination, sample lots of cleaned seed from all improved alfalfa seed fields in production in California during 1948 were examined microscopically. Seeds visibly damaged—cracked, chipped, or broken—varied from 8% to 69% for different lots, with an average of 27%. These results left little doubt as to the cause of the poor germination of certain lots of seed.



Close-up view of a windrow-swather. The vertical cutter in the foreground separates the cut material from the standing growth. The pick-up reel contributes to a cleaner job of cutting and lays the material back onto the canvas draper which conveys it to the left side of the swather.

Revolutions Per Minute Required for Various Peripheral Speeds and Cylinder Diameters. Recommended Cylinder Speeds Are About 4,000 Feet per Minute If Flax Rolls Are Used, and Between 4,500 and 5,000 Feet Per Minute Without Flax Rolls.

Cylinder diameter, inches	Rpm to give 4,000 ft. per min.	Rpm to give 4,500 ft. per min.	Rpm to give 5,000 ft. per min.
14	1,090	1,230	1,360
16	955	1,075	1,190
18	850	955	1,060
20	765	860	955
22	695	780	870
24	635	715	795

Peripheral speed, ft./min. $= 3.1416 \times \frac{\text{cyl. diam., inches}}{12} \times$ rpm.

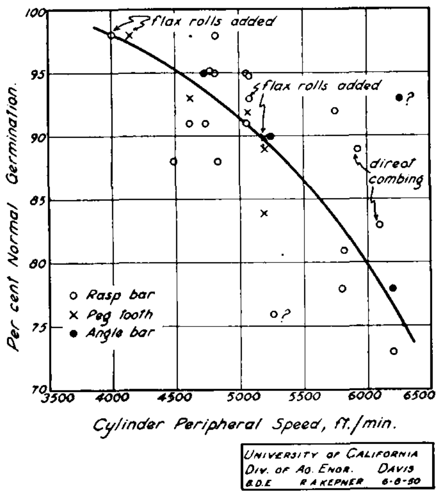
However, it was not apparent what processing operation was causing the breakage. The type of damage and the germination difficulties were similar to those encountered in the threshing of beans as a result of mechanical injury.

A field study of harvesting equipment and methods was undertaken during the 1949 season to investigate possible causes of seed damage, as related to type of machine, speed of operating parts, variety of seed, weather conditions, moisture content of seed, and any other contributing factors.

Through the cooperation of growers, 16 combine harvesters, including six makes and eleven different models, were tested and adjusted during a two-month period. Eleven of these combines had cylinders of the rasp-bar type, three were peg-tooth, and two were angle bar, rubber faced. Two of the rasp-bar and one of the peg-tooth machines were equipped with flax rolls. Five of the units were self-propelled.

To determine the source of damage as well as its extent under various operating conditions, seed samples were taken from the following locations while each machine was in operation: *1*, immediately behind the cylinder; *2*, discharge end of tailings return auger; 3, top of return elevator; 4, discharge end of clean seed auger; 5, seed spout at sacker or bin. Hand-threshed samples were also taken for comparison.

For each sample, the percentage of visibly damaged seeds was determined by microscopic examination. Machine adjustments were then made on the basis of this examination and new samples taken. This procedure was continued until the visible damage was reduced to



Relation of germination percentage to cylinder speed, for various types of combines. No significant differences are evident between the three types of cylinder. Seed moisture contents ranged from 5.2% to 7.5%.

about 5% or less. Final analysis of damage was based on germination tests.

The amount of seed lost over the rear of the machine was checked by dragging a canvas sheet behind the combine so as to catch all of the material discharged over a measured distance of travel. The seed was then separated by running the material through a hammer mill at low speed and then over a fanning mill. Observations were also made as to losses in other phases of the procedure, such as shatter during mowing and windrowing, losses caused by the pick-up attachment on the combine, and seed leaks from the combine itself.

The results of these tests and adjustments demonstrate that the amount of seed damage is closely related to the peripheral speed of the cylinder. In two cases, some damage was resulting from insufficient clearance between an auger and its housing; otherwise there was no indication of damage occurring at any place in the machine except in the cylinder.

The accompanying graph shows the relation between germination percentages and cylinder speed. Some of the plotted points represent the initial conditions before making any adjustments, and others represent the final checks made on the various machines after adjustment. Samples taken before making any adjustments had germination values ranging from 41% to 95%, with an average of 83.7%—about the same average as for these same machines in the same fields in 1948.

More than half of the 16 combines had excessive cylinder speeds when first checked. In some cases these excessive speeds were in agreement with the manufacturer's recommendations.

After adjustments had been made, germination results ranged from 88% to 98% with an average of 93.7%, 10% higher than before adjusting. The germination of hand-threshed samples averaged 99%.

For the conditions encountered during these studies, the best peripheral cylinder speed for machines not equipped with flax rolls appears to be between 4,500 and 5,000 feet per minute when threshing from the windrow. The results do not indicate any significant differences between the three types of cylinders.

In all tests where the windrow-combine method was used, seed moistures were within the narrow range from 5.2% to 6.8%. In the one instance where direct combining was observed, the seed moisture content was 7.5%, and somewhat higher cylinder speeds were being used.

In general, the benefits derived from reducing cylinder speeds are not confined to improved seed quality. The lower speeds leave the straw in much better condition—longer pieces and less chaff—so that the seed can be separated and cleaned more efficiently, with less loss over the rear of the machine. However, speeds must be great enough to remove the seeds from the pods. The minimum satisfactory cylinder speed will be influenced somewhat by the moisture content of the straw and by the amount of material being handled by the machine.

The use of flax rolls allowed cylinder speeds to be reduced to about 4,000 feet per minute without sacrificing thoroughness of threshing, but with the advantages of minimized amounts of seed damage and reduced losses over the rear of the machine. The flax rolls retard the straw and hold it so that the cylinder has more of a combing action, which improves its threshing effectiveness at a given peripheral speed. Also, some of the seed is removed from the pods directly by the flax rolls and drops onto the grain pan without having to pass through the cylinder.

Clearances used between cylinder and concaves ranged from one-eighth inch to five-sixteenths inch, with three-sixteenths inch being the most common. In most cases the shoe was equipped with one adjustable lip sieve and a round-hole screen. A few machines used a second sieve, and two were equipped with recleaners. Most of the machines used screens with one-twelfth inch or one-tenth inch holes, although a few had larger sizes where the seed was large or the yield extremely heavy. On one machine, one-eighth inch mesh hardware cloth was tried in place of the round-hole screen but it would gradually become clogged with straws. On another machine, one-fourth inch mesh hardware cloth was put on top of the straw rack in an attempt to relieve the load on the shoe, but it clogged almost immediately.

Because of the relatively large amounts of chaff and small pieces of straw encountered in harvesting alfalfa, the limiting

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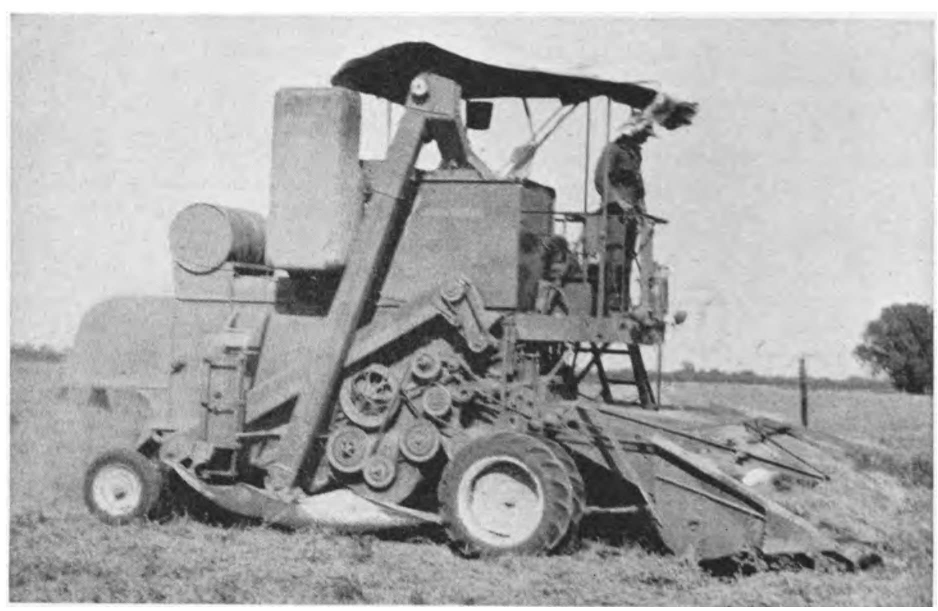

Self-propelled combine harvesting in a field with heavier-than-average windrows. The canvas sheet suspended beneath the machine catches any seed that leaks out. The ground-driven belt-type windrow pick-up was the most satisfactory type observed. The windrow here is being lifted with a minimum of disturbance.

DISEASES

Continued from preceding page

vored by moisture. Bacterial stem rot of delphinium frequently decimates seed or flower crops grown with overhead sprinkling, but is insignificant when ditch irrigation is practiced.

Conditions that restrict air movement and rapid drying favor some diseases. For example, a recent outbreak of Botrytis gray mold on chrysanthemum flowers in San Mateo County was much more damaging under a complete than under a partial cloth-house cover.

The grower should understand how continuous cropping may lead to economic loss from the subterranean phase of a disease—such as black leg of brussels sprouts—that would otherwise be unimportant here. Use of clean seed of this crop to prevent either introduction of the organism to the land or its intensification if already present, is important even under dry conditions. The benefit from using disease-free seed is not limited to the single crop but extends to future ones as well.

Climate has been one of the factors that has made California a great agricultural state. It is a powerful ally in preventing losses from plant diseases, and growers should adopt cultural practices which will fully capitalize on it.

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factor on the capacity of any of the combines studied was in the cleaning ability of the machine, or in other words, the size and effectiveness of the shoe.

In some of the fields which had exceptionally heavy crops, the windrows were so large that it was a problem to reduce the forward speed of even the larger combines to the point where losses over the rear of the machine were not excessive.

For example, checks at three speeds with one of the larger combines taking a windrow from a 10-foot cut, gave the following losses: 10 pounds per acre at 0.8 mph, 35 pounds per acre at 1.2 mph, and 74 pounds per acre at 1.4 mph. These tests were in one of the heaviest fields observed. With another machine, the loss increased from 11 to 149 pounds per acre when the forward speed was increased from 0.9 to 1.3 mph.

In another field with exceptionally heavy growth, the combine had to be operated with one or the other of the main wheels upon an irrigation border for about one third of the windrows. The loss with the machine level was 52 pounds per acre, but was twice as much when the combine was tilted either way—at an angle of about five degrees.

The method and care used in cutting and windrowing the crop has considerable effect on the quality of the threshing job. Windrows which are bunchy and uneven cause the combine to be alternately overloaded and underfed, resulting in increased losses and damage to the seed. Also, considerable seed may be shattered and lost in the windrowing procedure itself.

The two types of equipment observed were the windrow-swather which cuts the material and conveys it to one side by means of a draper, and the standard mower with curler attachment which relies upon dragging curved bars and contact with the stubble to roll the material over into a windrow. The latter involves the least investment in equipment, but tends to give bunchy windrows, especially where the growth is light.

Another source of loss is seed shattered by the windrow pick-up device on the combine. It is highly desirable that the pick-up be driven from a ground wheel, with a peripheral speed perhaps 10% greater than ground speed. This will result in a minimum amount of disturbance as the windrow is picked up. Of the various types of pick-up units noted, the most satisfactory was the belt-type, operating with a rather flat slope.

The machines under observation in this investigation harvested 600,000 pounds of seed from 1,120 acres, for an average yield of 535 pounds per acre. The yields from individual fields ranged from 100 pounds to slightly over 1,000 pounds per acre. Visible seed damage averaged 17% for the 16 combines as initially operated, and 5.3% after the machines had been adjusted. The average germination loss caused by the combine—compared to hand-threshed seed—was reduced from 15.3% to 5.3% by the adjustments.

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