Harvesting Small-Seed Legumes

successful performance of combines depends equally on cultural practices and on operation of harvester

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Approximately 250 seed harvesting tests with seven different crops—alfalfa, Ladino clover, red clover, alsike clover, Birdsfoot trefoil, barley, and Merion bluegrass—were made during the three years of 1951–1953 on 30 different combines and two stationary threshers.

Because of high cash returns, small-seeded legumes are grown extensively in the interior valleys of California, and most growers follow cultural practices that will maximize seed yield. Consequently, California is a leading producer of certified alfalfa and Ladino clover seed.

When approximately 10% of the California seed crop produced for certification in 1948 failed to pass minimum germination requirements, staff members of the departments of agronomy and agricultural engineering at the University of California undertook to determine the causes. Other problems related to alfalfa seed harvesting were also studied.

Equipment and Operation

Preliminary investigations in 1949 indicated that proper adjustment and operation of harvesting equipment could increase the average germination of alfalfa seed by 10% and could reduce field losses considerably.

Because most of the small legume seed acreage in California is harvested with 12′ to 16′ self-propelled combines, nearly all of the 1951–1953 tests were made on such machines.

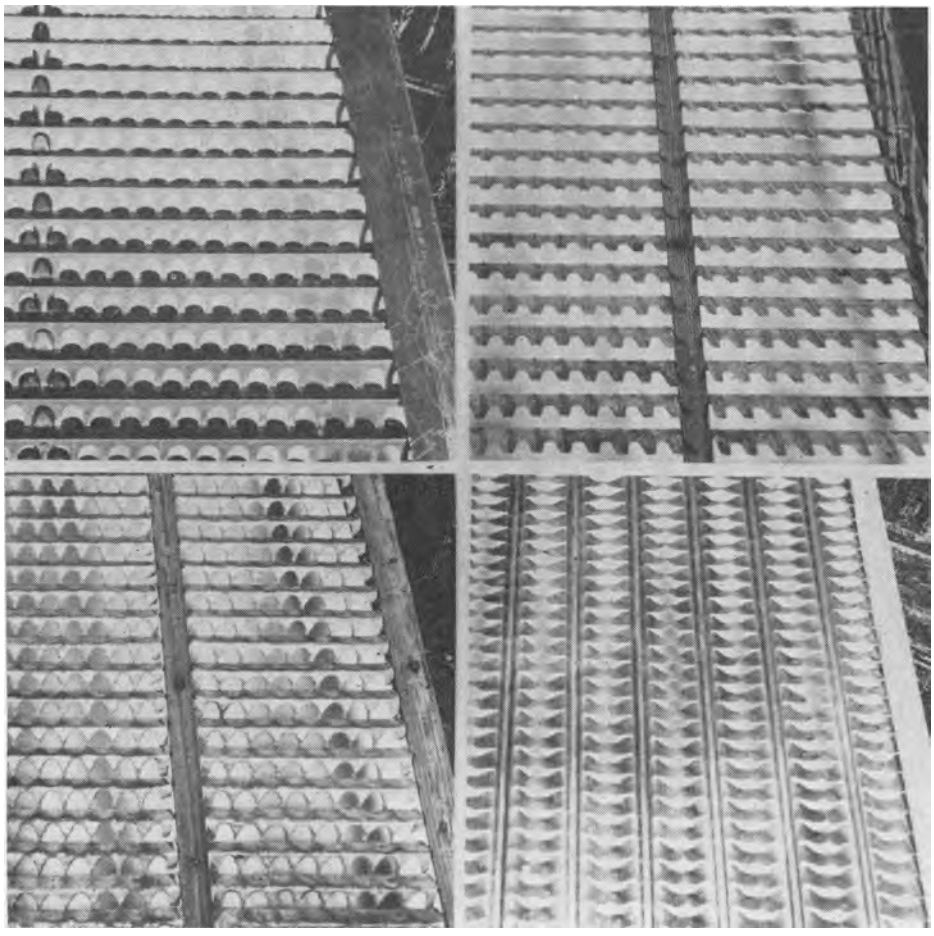
Combine performance was determined by test procedures in which the straw from the straw walkers, the chaff from the shoe, and the clean seed from the delivery spout were collected separately—and simultaneously—while the combine was traversing a measured distance. The time to traverse the measured distance—usually 25′ to 50′—was recorded by a stop watch, and the swath width was measured. In most cases, tests at three or more feed rates, covering a considerable range, were made for each set of combine adjustments. The change in feed rate was obtained primarily by varying the forward speed of the harvester.

The walker and shoe fractions were analyzed in the laboratory for free and unthreshed seed. A fanning mill was used to recover the free seed contained in each of these fractions. The unthreshed seed was then recovered separately by using a hammer mill to rethresh the seed and the fanning mill to recover it.

A sample of the seed collected from the grain spout during the test was examined in the laboratory for threshing damage. The per cent of visible damage for the sample was determined by examining several groups of 100 seeds under a binocular microscope.

In some of the tests, the tailings were collected for a short period of time—10 to 15 seconds—immediately after the regular run was completed, without stopping the machine. Most of these tests were made on a harvester equipped with a special gate at the discharge end of the return elevator to allow the tailings to be easily and completely collected.

Portions of chaffers tested: *Upper left*, riffle chaffer; *lower left*, Peterson chaffer; *upper right*, adjustable lip chaffer; *lower right*, no-choke chaffer.



Preparation of Crop

The most common method of preparing the crop for harvest is windrowing, although in recent years spray-curing has gained rather wide acceptance. The spray causes desiccation of the plant, particularly the leaves, pods, and growing points. As soon as the moisture content of these parts drops to 15% to 20%, the crop is ready for harvest, even though the stems may still have a moisture content of 50% or more. When harvesting from the windrow, the average moisture content, including both leaves and stems, ranges from 12% to 18%.

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In alfalfa, the cutter-bar losses are usually quite low when proper harvesting methods are used. Losses of 5–10 pounds per acre are usual, although losses of only two pounds per acre have been observed. In Ladino clover, under good conditions, with level fields and with the header modified to permit cutting within ½" to ¾" above the ground, losses may be as low as 15 to 20 pounds per acre. Less favorable conditions may easily double these losses. Cutter-bar losses for the other legumes fall between the extremes represented by alfalfa and Ladino clover.

Seed Damage

Peripheral speed of the cylinder is the most important factor in seed damage. Previous experiments by other workers have demonstrated that an increase in cylinder speed reduced the percentage of germination of alfalfa seed.

Seed damage is reduced as the load in the cylinder is increased. Also, damage is generally low when the moisture content of the seed is high. High moisture content in the straw and greater leafiness provide padding which reduces damage.

Clearances in the cylinder, augers, and elevators are of little importance in seed damage until they approach the maximum seed dimension. Damage to seed in the tailings is slight, even though 10% to 20% of the total seed load in the harvester may be circulating in the return.

At the end of the season, germination tests were run on the samples that had been examined for harvester damage. The correlation was very close between per cent visible damage and the per cent of seed that failed to germinate or that which produced abnormal plants.

Threshing Operation

Under California conditions, a combine in small-seeded legumes must handle from 1½ to three tons of straw and chaff per acre and is normally operated at forward speeds of ½ mph to 1 mph. The resulting feed rates in alfalfa seed harvesting generally range from 40 to 90 pounds per minute, while they are usually somewhat lower in Ladino clover. When properly adjusted, the unthreshed seed loss for a particular size of combine is about proportional to the rate at which material is fed into the machine. Unthreshed seed is normally the largest single loss from the combine.

The particular peripheral cylinder speed used to harvest any of the small legume seed crops is the result of a compromise between thoroughness of threshing and amount of seed damage. These two factors may vary directly or inversely. For example, Ladino clover seed is difficult to thresh, but high peripheral speed can be used because the seed is not easily damaged, whereas red clover is very difficult to thresh and is easily damaged. On the other hand, alfalfa is easy to thresh, and damage becomes excessive at medium peripheral cylinder speeds.

Straw Walker Performance

Free seed losses over the walker—or rack—increase with load but more rapidly than the load.

In harvesting small-seeded legume crops under usual conditions in the state, the walkers carry a smaller portion of the total combine load than they do in grain harvesting. The limited tests in barley showed that the walkers retained two thirds of the total weight of straw and chaff passing through the machine.

In windrowed alfalfa, the walkers handle about half of the total load, while in windrowed red clover, the walkers carry less than one third of the total straw and chaff.

In spray-cured crops, the straw has a higher moisture content and does not break up as badly. As a result, a higher percentage of the straw and chaff is retained on the walkers. Generally, as the load rate increases, the walkers carry proportionally more of the total load. Numerous attempts have been made to improve the performance of combines in small-seeded legume harvesting by covering the walkers with fine mesh material. While this action has helped reduce the load on the shoe, it has generally resulted in a considerable increase of seed losses over the walkers.

Cleaning Shoe Performance

When harvesting small-seeded legumes, the cleaning shoe must handle a relatively large amount of chaffy material separating seeds that are minute in comparison with the cereal grains—200,000 to 800,000 seeds per pound as compared with 8,000 to 24,000 for barley and wheat. For the small-seeded legumes, the shoe is therefore adjusted for maximum seed recovery rather than for a good job of cleaning, as is customary in grain harvesting.

The average number of seeds per pound for alfalfa is 200,000; for red clover, 275,000; alsike clover, 680,000; Ladino clover, 800,000; and for Birdsfoot trefoil, 500,000. In spite of this big difference in individual seed weights, there is little difference in the settling velocities of these seeds. Because of the small difference in settling velocities, the cleaning shoe recovers the smallest seeds nearly as efficiently as it recovers the largest seeds. For example, when harvesting Ladino clover seed, the wind on the cleaning shoe is reduced about one fourth from the amount that is used for harvesting alfalfa. There is a difference in the mill cleanout for these two crops; 30 to 40 per cent for Ladino clover and 10 to 20 per cent for alfalfa. This difference in cleanout is a result of the reduced cleaning shoe wind velocities and the large amount of fine material in the Ladino clover chaff.

The amount of wind on the cleaning shoe can seriously affect its separating efficiency. The free seed loss usually increases rapidly when the wind velocity is too high or too low. In the case of high wind velocities the increased loss is a result of seed being blown out of the shoe. For the low velocities the increase in free seed loss is due to a greater load on the shoe which carries the seed out with the chaff.

There is some difference in the efficiency of chaffers. The adjustable-lip chaffer has shown consistently good performance in all tests. The double no-choke chaffer, which consisted of a No. 0 no-choke, about 3" above a smaller No. 2 no-choke, performed very well in the series of alfalfa tests but did not perform as well in red clover. At normal load rates and when properly adjusted, the Peterson, riffle and adjustable-lip chaffers showed relatively little difference in performance.

Seed Recovery

In small legume seed harvesting, a considerable portion of the seed passes through the cylinder unthreshed. The majority of this unthreshed seed is normally recovered in the separating operation and returned to the cylinder for rethreshing. The remaining unthreshed seed is lost over the back end. Consequently, the loss of unthreshed seed is closely related to the efficiency of the separating mechanism. Recovery of unthreshed seed improves as the chaffer openings are increased.

This same effect is also evident in the recovery of free seed in spite of the accompanying increase in tailings. Adjustable-chaffer openings of about ½" have proved satisfactory for machines with adequate return capacity. In alfalfa, with a ½" chaffer opening, the material load in the return system varies from 50% to well over 100% of the net shoe load.

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