METHODS OF HANDLING HAY IN COLORADO

By G. A. CUMINGS
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METHODS OF HANDLING HAY IN COLORADO

By G. A. CUMINGS

Hay is extensively grown in every section of Colorado where sufficient moisture is available, and is necessarily handled under a wide range of conditions. The quality of hay is determined almost entirely at the time of stacking, which means that organization and efficiency are of supreme importance to the hay grower.

The purpose of this bulletin is to describe, in a general way, the common and successful methods of curing, stacking and protecting hay in the State of Colorado.

Several kinds of hay are grown but alfalfa is the principal one and unless special reference is made to a particular kind, alfalfa will be the one under discussion.

Averages taken from a large number of estimates are given for the State as a whole, and should be considered as only approximate when applied to specific cases.

IMPORTANCE OF THE HAY CROP IN COLORADO

According to the Fourteenth census of the United States (1920) the acreage and value of hay exceeds those of any other crop grown in Colorado. Approximately 1,600,000 acres or 32 percent of the crop area of the State is given to hay, the value of which is 38 percent of the value of all other crops combined.

The various kinds of hay grown in Colorado are, in the order of their acreages: Alfalfa, wild or native hay, green grains, mixed timothy and clover, millet, timothy, sudan grass, sweet clover, field peas and clover. Other kinds of hay are grown but not to any great extent. Hay is grown at elevations from 3,500 to 8,000 feet, on all kinds of soil and under a wide range of climatic conditions.

The hay crop, even under the more favorable conditions found in Colorado at the time of making hay, requires more constant attention and efficient handling than other crops. Cutting and stacking are limited to a comparatively short period of time if done without a material loss of quality and quantity of hay. Any delay in stacking operations is very costly; the valuable time of a large stacking crew is lost; tons of hay may be lost by shattering, leaching, extra handling and difficulty in raking, especially if enough time has elapsed for the next crop to get started; the hay is of inferior quality because of the bleaching, loss of leaves, and improper curing.

The successful hay grower must possess unusual ability. He must be able to plan his work, organize his crew, exercise good judgment, come to quick decisions in case of unfavorable
weather or accidents and, above all, he must be able to handle large crews of men.

**TIME OF CUTTING**

The stage of maturity at which alfalfa hay should be cut is indicated in two principal ways: First, when new shoots are well started at the crown of the plant. Later cutting gives a decrease in yield, woody and less palatable hay, and, by clipping off the new shoots, retards the next crop. Secondly, from the time bloom first appears until one-half in bloom is considered the best time to cut. Wild or native hay is cut from the time it blooms until ripe, green grains in the milk or dough stage, mixed timothy and clover when the timothy reaches second color of bloom, millet in the milk stage, timothy in second bloom for horses and earlier for cattle, Sudan grass in full bloom, sweet clover at first bloom or before, field peas when most of the pods are ripe, and clover in full bloom.

**IRRIGATING BEFORE CUTTING**

When hay is irrigated to start the next crop it should be done at least three or four days before cutting. If sufficient time is not allowed for the ground to become firm, difficulties will be experienced in mowing, the draft of all machinery will be greatly increased, the ground will be marked by deep wheel tracks and hoof prints, and there will be more time required and uncertainty in proper curing.

Fig. 1. Two-horse mowers cutting second crop alfalfa hay.
MOWING

On the larger hay ranches mowing is almost a continuous operation from the time cutting starts until the close of the haying season. From one to six mowers are operated depending upon the acreage, yield, and size of crew. Since moisture does not materially injure newly mown hay, it is not always advisable to discontinue mowing during unfavorable weather where hay is liable to ripen too much or a large acreage must be handled. Hay is easier to handle and cure when cut in favorable weather.

Mowers.—The mower with a five-foot cutter bar is the one most commonly used. Compared with wide-cut mowers, it is light, has less draft and is more convenient to handle along fences and ditches. The 6-foot and 8-foot two-horse mowers, and 8-foot and 10-foot tractor mowers are coming into more general use. Figure 1 shows two-horse mowers in operation.

The wide-cut mowers are particularly adapted to large ranches where the stand of hay is not heavy enough to give excessive draft for an average team. Tractor mowers are of interest only to the man who uses a tractor for other farm work. They have been used successfully where labor is scarce or the acreage is large. By using a two-horse mower in connection with a tractor mower to mark out ditches, cut along fences and finish lands, very large acreages are cut per day. A tractor mowing outfit is shown in Figure 2.

Mower Troubles, Care and Repair.—The common mower troubles are: Heavy draft, worn and loose parts, non-centering
of sickle, non-alignment of cutter bar, broken pawls, dull or broken sickles, dull ledger plates and gummed cutter bars.

The remedies for worn clips or wearing plates, loose sections, loose bearings, broken pawls, dull sickles or ledger plates, broken sickles and bent guards will not be discussed for they should be obvious to the hay grower. Heavy draft is usually caused by poor lubrication, dull sickle, and non-alignment. Non-alignment of a cutter bar is often overlooked by the farmer. It is caused by wear of the yoke pins which allows the end of the cutter bar to fall back out of line with the pitman. A string stretched along the center line of the pitman should fall on similar points along a properly aligned cutter bar. (See Figure 3.) When no adjustments are provided, the cutter bar may be aligned by properly bushing around the yoke pins. The ordinary adjustment on the drag bar is not intended to align the cutter bar and if wrongly used as such, produces another serious trouble of non-centering of the sickle without correcting the non-alignment.

The sickle is centering or registering when the sections stop in the center of the guards at either end of the stroke. Non-centering, as shown in Figure 4, would leave strips of grass uncut. The drag bar or pitman adjustments are used to center
Fig. 4. Centering and non-centering of sickle.
the sickle. Sickle sections ground to a point are liable to leave strips of grass uncut.

Heavy gum on the parts of the cutter bar is formed under certain conditions by the mixture of oil and grass juices. Water poured on the cutter bar will tend to remove the gum. When gum interferes to any extent, oil should not be used on parts of the cutter bar kept moist by grass juices.

Excessive side-draft is a good indication of an improperly adjusted cutter bar.

**CURING HAY**

The method of curing hay depends upon the kind of hay, quality of hay desired, use of hay and climatic conditions. Practically all of the hay is cured either in the swath and windrow or in the cock. Frequently timothy hay and grasses are cured in the swath, and alfalfa is partly cured in the stack.

![Image of curing hay](image)

**Fig. 5. Curing hay in the windrow.** Windrows permit a free circulation of air thru the hay and prevent excessive bleaching.

**Curing Hay In the Swath and Windrow.**—A majority of the hay growers, stacking on a large scale, allow the hay to lie in the swath until wilted, then rake it into windrows with sulky or side-delivery rakes, where curing is completed. Hay raked into windrows allows a free circulation of air which rapidly carries away the moisture given off by the leaves. (Figure 5.) This method is faster, requires less labor, and gives a good quality of hay, compared with the other methods of curing. The time between cutting and raking will depend upon the stage of maturity and weather conditions, but a better quality of hay will be secured if most of the curing is done in the windrow
rather than the swath. From 3 to 7 days are required to cure hay in the windrow.

Hay, which has been partly cured in the windrow, is often bunched with a sulky rake, thus loosening it up and insuring thorough curing, as well as simplifying the work of the sweep rake. Bunching hay in this sense is not cocking but simply a second raking, as shown in Figure 6. Since less hay is exposed when bunched, there will be less bleaching and shattering provided the hay is bunched before it gets too dry. In case of rain, bunched hay does not dry out readily, but is considered to be of better quality if allowed to dry out well before turning.

Fig. 6. Bunching hay with a sulky rake to hasten curing and reduce bleaching.

Curing Hay In the Cock.—In sections of the State where weather conditions interfere with curing or where a superior quality of hay is desired, hay is cured in cocks. As soon after cutting as the hay is free from any surface moisture it is raked and piled into cocks, as shown in Figure 7. Smaller cocks of 100 pounds or less are preferred. From 5 to 10 days are required for the hay to cure, depending upon existing conditions. Hand labor is necessary in building cocks and pitching hay out of cocks, making this the slower and more expensive method. Hay cannot be satisfactorily handled on a large scale where so much time and hand labor are required in curing, consequently this method is not used on the largest ranches.

Hay cured in the cock is of a superior quality, containing little bleached hay and retaining a bright green color. Since a much greater percentage of the leaves, the most nutritious part of the plant, is also saved, the hay makes a more palatable and valuable feed.
Curing Hay In the Swath.—Timothy hay and grasses are sometimes cured in the swath, when the weather is not too hot. Where the yield is heavy, as in parts of Routt County, a tedder may be used to loosen up the hay. Curing is seldom completed in the swath. The advantages of curing hay in the swath are: (1) The hay will dry out faster in case of rain. (2) Timothy and grasses do not permit as free circulation of air through windrows as alfalfa, and will cure faster in the swath. Disadvantages of curing hay in the swath are: (1) Hay gets too dry and bleached on top before it is properly cured below. (2) The methods of stacking hay make it necessary to rake the hay into windrows, which results in shattering and loss of hay if it is cured before being raked. (3) Uneven curing, bleaching and shattering produce poor quality hay.

Curing Hay In the Stack.—It is a common practice among sheep and cattle feeders to stack a part of their hay before it is entirely cured. It has been the experience of the most prominent hay growers to stack green hay directly from the mower without damage. Hay partly cured in the stack produces an immense amount of heat which gives the hay a dark brown color. Such hay is called "stack-burnt." It is not advisable to stack hay too green for it becomes dangerously hot and may be damaged. "Stack-burnt" hay is recommended for sheep or cattle but not for horses. The effects of "stack-burnt" hay are similar to those of green grass in the spring. It is a change of feed and the animals eat more of it. The feeding value is no greater than that of other hay, but sheep and cattle relish it more and by eating larger quantities, temporarily at least, gain more in weight and milk production.
CURED HAY

An experienced hay grower has no difficulty in determining when hay is cured. By handling the hay he can tell, by the odor, touch and sound whether or not it is cured. The stems are the last part of the plant to cure and tests should be made on them. Hay is cured when: (1) Twisting a wisp does not bring out any moisture, (2) the stems appear dry and will break, (3) the hay feels dry, and makes a rattling noise when handled.

RAKES

Sulky and Side-Delivery Rakes.—The sulky rake is universally used and an indispensable machine for hay making. (See Figures 6 and 8.) The side-delivery rake is used to an advantage by a large number of hay growers. At least one sulky rake is used in connection with side-delivery rakes to rake along ditches and bunch the hay. Figure 9 shows a side delivery rake in operation.

The advantages claimed for the side-delivery rake are: (1) More economy since both side-delivery rakes and sweep rakes may be operated lengthwise of the field. (2) It makes a straight clean-cut windrow. (3) Hay is left in a better condition for...
curing. (4) It is most convenient when used with hay loaders, and (5) handy for turning windrows. The disadvantages of the side-delivery rake are: (1) It tends to "rope" hay, especially tough hay. (2) Sweep rakes have more difficulty in taking hay from the windrow. (3) It is impossible to rake close to ditches with the side-delivery rake.

![Sweep Rake Loading](image1)

Fig. 10. A typical sweep rake loaded with hay. (Courtesy of the International Harvester Company of America.)

**Sweep Rakes.**—Figure 10 shows a typical sweep rake loaded

![Sweep Rake Loading](image2)

Fig. 11. Sweep rake loading an overshot stacker. Where large quantities of hay are handled an extra push by the sweep rake is necessary to satisfactorily load the stacker.
with hay. Many kinds of sweep rakes are on the market and used by hay growers in this State. The three- and four-wheel, rear hitch power or horse-lift rakes are most commonly used.

**Fig. 12.** Operation of the overshot stacker.

**METHODS OF STACKING HAY**

Many different kinds of stackers are used in Colorado, but practically all of the hay is stacked with one of five general types, namely: Overshot, swinging, combination, derrick and slide. The unique situation in the North Park region, where the slide is the only stacker used, will be taken up under slide stackers.

While the location of a ranch, acreage of hay, method of irrigation, climatic conditions, number and age of children, kind and amount of hired labor, kind of hay, use of hay, and initial cost of machinery are determining factors in the choice of a stacker, the stacker is usually chosen by personal preference of the hay grower. All

**Fig. 13.** Overshot stacker delivering hay to the stack. This stacker has adjustable arms and may be shortened for starting a stack.
the common stackers are used and adapted to the various conditions found in each section of the State.

**Overshot Stackers.**—The overshot stacker is used in every hay section of the State except the North Park region, and in greater numbers than any other type of stacker. It is light, easily moved, does satisfactory work, is cheaper than most patent stackers and is built by many manufacturers in various forms and sizes. Figures 11 to 16 inclusive show several types of overshot stackers.

The main objection to this type, as with other patent stackers, is the lightness which, under the heavy loads and strains, results in breakage and delay at critical times during the stacking period.

Stacks may be built as high as 26 feet but 20 feet is the average height.

Figures 11, 12, 13 and 14 show very clearly the principle upon which overshot stackers operate. The hay is carried directly over the stacker proper, and deposited on the center of the stack. Stop ropes, attached to compression springs, relieve the stacker of excessive strains when the stacker head is stopped in its delivery position. Sweep rakes cannot load stackers of this type with large quantities of hay without giving the hay an extra push, as shown in Figure 11. From one to four men are required to distribute the hay, depending upon the number of sweep rakes, length of haul, and size of stack, but seldom over two are necessary.

While the overshot stacker insures a stack with a firm center, the kind of stack built depends upon the condition of the hay, efficiency of the men on the stack, and the time given to distribute the hay.

The maximum capacity is no doubt greater than that of any other stacker except the slide, due to the shorter time required to operate it. The maximum capacity is of no advantage to the average crew since hay is not hauled.
in fast enough to keep the stacker in continual operation. An efficient crew can stack about 4.5 tons per man per day.

With large crews the capacity of the stacker is often increased by giving the stacker a quicker action. The system of pulleys is replaced by a cable on a double drum horse-driven hoist. As the hay is delivered to the stack, the cable is detached from the stacker team, and the man operating the hoist immediately lowers the stacker head by means of a brake. The stacker is loaded by the time the stacker team has returned. Although an extra man is required to operate the hoist, the maximum capacity of the stacker is greatly increased.

One or more adjustments are usually found on overshot

Fig. 15. An automatic overshot stacker which allows the hay to slide off the delivery teeth several feet to either side of center. (Insert, courtesy of The Superior Hay Stacker Company.)
stackers. The length of arms may be changed to correspond to the height of stack. Non-adjustable stackers are simpler and stronger but they carry hay to an unnecessary height with more difficulty in wind when the stack is low, and are not compact for storing or transporting. Figures 13 and 14 show adjustable and non-adjustable stackers delivering hay to a newly started stack.

Adjustments essential on a stacker with non-adjustable arms, are: Changing vertical angle of delivery teeth and length of stop ropes. By raising the delivery teeth or lengthening the stop ropes by changing the position of the compression springs, the hay is deposited on the center of the stack as the height of stack increases.

An adjustment recently introduced, changes the horizontal angle of the delivery teeth, which throws the hay several feet to either side of center. Due to the principle of operation, the hay slides off the teeth instead of being thrown off. Figure 15 shows a stacker of this type. Note the angle of the delivery teeth, as the hay is delivered.

![Fig. 16. A type of overshot stacker mounted on wagon trucks for convenience in moving.](image)

The crews operating overshot stackers investigated in the preparation of this bulletin varied in size from 3 men and 3 horses to 16 men and 26 horses. The most common sizes of crews are from 6 to 9 men, which are most efficient. Large or small crews are used as circumstances demand but usually the larger crews are inefficient by having a man or machine idle a part of the time. The 4- and 5-men crews are efficient crews on smaller acreages where all of the stacking operations are not continually carried on. Typical crews are shown in the following table:
### TABLE I. Stacking Crews used with Overshot Stackers

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<th>Stack</th>
<th>Sweep rakes</th>
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<th>Stk.'s Op'tr</th>
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* Mowing and raking are not always continuous operations and the men and horses may be shifted from one machine to another.

† Numbers in parentheses represent men and horses used on other parts of the crew.

‡ Arrangements of crews other than those mentioned in the table are used under exceptional circumstances.

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**Fig. 17. An automatic swinging stacker with the head loaded and the trip set to deliver the hay at a predetermined point on the stack.**
Swinging Stackers.—The swinging stacker which in many ways is similar to the overshot, is built in several forms and sizes. The swinging stacker is necessarily a little more complicated in construction than the overshot stacker but is not subject to any more difficulties. It is extensively used and does very satisfactory work. It is built light and convenient and is subject to breakage under heavy strains.

Notwithstanding the fact that certain parts of most patent stackers are built too light and weak, breakage is often due to carelessness on the part of the stacking crew. The stacker may
be loaded too heavily, the stacker team driven carelessly, or the repair of weak parts neglected.

The average height of stack built is about 20 feet, with a maximum height of about 26 feet.

Figures 17, 18 and 19 show very clearly the operation of a swinging stacker. The hay is carried to the height of the stack, swung around and dropped at any desired point on the stack. Unlike the common overshot stacker the hay slides off the teeth instead of being thrown off. Figure 18 shows a stacker which may be loaded at either side and also the manner in which the hay is delivered. Stackers loaded from either side may be

Fig. 20. Hand controlled swinging stacker with which the operator can accurately place the hay on the stack. (Courtesy of The International Harvester Company of America.)

loaded on the side most convenient for the sweep rakes, which gives less difficulty in case of a strong wind, or nearest the stacker head when it is tripped.

Delivering hay where it is desired greatly reduces the labor on the stack and to such an extent that sometimes the men get careless in distributing the hay which permits moisture to readily penetrate the stack.

The average number of men employed on the stack for overshot stackers is 1.8, for swinging stackers 1.3, which indicates that in many instances one less man is required on the stack.

Adjustments on swinging stackers are conveniently made for height of elevation and time of delivery.
Swinging stackers may be either hand controlled or automatic. Hand-controlled stackers are swung (with the aid of the stacker team) and tripped by the operator. Hay is accurately placed which greatly reduces labor on the stack. Figure 20 shows a hand-controlled swinging stacker.

Automatic swinging stackers mechanically elevate, swing, and trip the stacker head. (See Figure 19.) The stacker-team driver sets the trip to deliver the hay at any predetermined point in the circle of the stacker. Altho the hay may not be as accurately placed as with the hand-controlled stacker, the operator is eliminated.

Hay is stacked at an average rate of 4.3 tons per man per day which is practically the same as for overshot stackers. The maximum capacity which is seldom reached is no doubt less than that of the overshot stacker. Double drum hoists are used to increase the maximum capacity and eliminate a system of ropes and pulleys.

The size of crew is the same as those given in Table 1, page 17, with the exception of the number of men on the stack. As previously mentioned in this discussion, frequently one less man is required on the stack.

**Combination Rake and Stacker.**—The combination rake and stacker, sometimes known as a portable stacker, altho less used than the stackers previously discussed, is found in nearly every hay section of the State. Since the hay may be delivered at any point of elevation, this stacker is not built in a number of different sizes. It is light compared with other stackers but when it must be pulled thru any great distance, more work is required of the stacker team than with other stackers. The amount of work placed on the stacker team tends to limit the size or height of elevation of the combination stacker. Some stackers elevate the hay about 23 feet but the average height of stack is not over 18 feet.

The combination stacker can be used as either a sweep rake or
a stacker. It is self loaded from windrows or loaded by sweep rakes. (See Figures 21, 22, and 23.) The stacker head is elevated by a cable drum on the main axle and can be locked at any desired height by engaging a ratchet or brake and releasing the clutch. By the further aid of a steering wheel in the rear and a delivery trip, the stacker is under positive control of the operator. Hay is delivered to the stack by tilting the stacker head and allowing the hay to slide off. After the hay has been delivered, the lowering of the stacker head assists the horses in backing the stacker, although the stacker head may be lowered independently by the operator. A medium weight or heavy team is necessary to successfully operate the combination stacker.

Sweep rakes could be eliminated by loading the stacker from windrows but the machine is too large and heavy to be pulled through any great distance. The most common method of loading the stacker with small crews, is to deposit the hay with sweep rakes in
Fig. 24. Loading a sling carried by a "slip" which eliminates any unnecessary height of pitching.

bunches near the stack, and self load the stacker as desired. As shown in Figure 23, the stacker conveniently approaches the stack at any point, thus reducing labor on the stack to a minimum. Large crews usually load the stacker directly from sweep rakes as shown in Figure 22. The stacker is used only on one

Fig. 25. A sling carefully loaded by the pitchers greatly reduces labor on the stack.
side of the stack and backed far enough each time to allow room for the sweep rakes to unload and to enable the stacker to elevate the hay to the desired height when advancing towards the stack.

The capacity is the same as that of swinging stackers. The average amount of hay stacked per man per day is about 4.3 tons for large crews and 4.7 for small crews, showing a greater efficiency than other stackers for small crews.

The size of the crew employed when the stacker is loaded directly from the sweep rake, is the same as those mentioned in Table 1, Page 17, except frequently one less man is used on the stack. Combination stackers have a great advantage with small crews. For instance with a crew of 2 men and 4 horses, both men mow and rake until a quantity of hay has been deposited in bunches near the stack, then raking is discontinued while one man operates the stacker and the other stacks the hay. With a three-man crew, one man drives a sweep rake, another the stacker and the third stacks the hay.

**Derrick Stackers.**—The derrick stacker has been used in every hay section of Colorado, including the North Park region. However, it has been abandoned in North Park, because of the superiority of the slide stacker. The derrick is a home-made stacker, consequently is built in many forms and sizes as may be noted in the accompanying Figures. Slings or forks are used with derrick stackers. The Mormon type of derrick stacker is the one most commonly used and is built very strong and heavy, making it reliable but inconvenient to move. (See Figure 26.) Very large and high stacks are built with derrick stackers. The height of stack is usually not over 30 feet, although the stacker is built any reasonable height which the hay grower might prefer.

When using a derrick stacker the hay is generally cured in cocks, as explained on page 9, then pitched.
by hand onto "slips"* or wagons and hauled to the stacker. "Slips" eliminate any unnecessary height of pitching and a man to load them, as shown in Figures 24 and 25. Slings are usually preferred to forks for they handle hay in large quantities without any shattering or scattering and deposit the hay on the stack in the same condition as it is placed on the sling. Therefore a large part of the labor in stacking is done by the pitchers who use care in loading the slings. Note in Figure 27 how the man on the stack does most of the stacking by properly locating the sling before it is tripped. Figure 27 also shows the operation of a derrick stacker using slings and "slips." Figure 28 shows the operation of a pole type of

derrick stacker using wagons and a fork. It is a satisfactory method of handling hay but very slow compared to other methods. Figure 29 shows a derrick stacker using wagons and slings. Wagons are not often used unless the hay must be hauled a considerable distance. By having the lower pulley located off center a few feet, the pull of the horses

* "Slip" is the term used among hay growers for a flat door-like skid about 6 feet by 12 feet which carries a sling.
swings the boom over the stack. The "slip" driver pulls the sling and boom back into a starting position with the trip rope.

The Wilson type of derrick stacker is similar to the Mormon type in its principle of operation and construction but much lighter in weight. As shown in Figure 30, the stacker is supported by a light base and three guys. It has two adjustments for raising or extending the boom, which are conveniently made. The Wilson type of derrick stacker is not used to any great extent because the Mormon type is more simple and durable.

In a few instances, on the larger ranches, sweep rakes are used with derrick stackers. Hay is cured in the windrow and hauled to the stacker on sweep rakes. A large sling, sunk flush with or a little below the surface of the ground, receives the hay and carries it onto the stack. The only advantage of this method is the reduction of hay losses by building large, high stacks.

Conditions under which the derrick stackers are best adapted are: (1) On small ranches where native timber is accessible, (2) Where hay growers desire large, well-built stacks and the best quality hay, (3) Where climatic conditions are such as to require special care in curing and stacking to preserve the hay, (4) Where topography
or type of irrigation interfere with the operations of sweep rakes, (5) Where hay must be hauled some distance to the stack, and (6) Where a small investment is essential.

The amount of hay stacked per man per day is about 3.1 tons which is only two-thirds as much as stacked with an overshot stacker.

The size of crew employed to operate derrick stackers varies with the amount of hay to be stacked. The size of the average crew is small, since derricks are not found on the larger ranches. The following table gives typical stacking crews for derrick stackers.

**TABLE 2. Stacking Crews used with derrick stackers.**

<table>
<thead>
<tr>
<th>Entire Crew</th>
<th>Arrangement of Crew</th>
<th>Extra Pitchers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men Horses</td>
<td>Stack Slips Stacker Team</td>
<td>Men Horses Men</td>
</tr>
<tr>
<td>2 4</td>
<td>1 (2) (4) 1 2</td>
<td>0</td>
</tr>
<tr>
<td>3 4</td>
<td>1 (2) (4) 1 2</td>
<td>1</td>
</tr>
<tr>
<td>4 4</td>
<td>1 2 4 (1) (2) 1</td>
<td>1</td>
</tr>
<tr>
<td>5 6</td>
<td>1 2 4 (1) (2) 1</td>
<td>1</td>
</tr>
<tr>
<td>5 6</td>
<td>1 3 6 (1) (2) 1</td>
<td>1</td>
</tr>
<tr>
<td>6 8</td>
<td>1 3 6 1 2 1</td>
<td>1</td>
</tr>
<tr>
<td>7 8</td>
<td>2 3 6 1 2 1</td>
<td>1</td>
</tr>
<tr>
<td>8 8</td>
<td>2 3 6 1 2 1</td>
<td>1</td>
</tr>
<tr>
<td>10 10</td>
<td>2 4 8 1 2 2</td>
<td>2</td>
</tr>
</tbody>
</table>

a. Figures in parentheses represent the same men or horses as on other parts of the crew.

b. Mowing, raking and cocking are usually done by the same men who pitch and stack the hay.

c. When wagons are used, several extra pitchers are necessary.

**Fig. 31.** A sweep rake depositing hay at the base of a typical slide stacker. Little time and care are required compared with the same operation with overshot stackers.
Slide Stackers.—The slide stacker is practically the only stacker used in North Park and surrounding territory because of the unique situation in those regions. Similar stackers are occasionally used in other parts of the State but are exceptional cases. The slide is a home-made stacker and is built in several forms and sizes. Height of stacks ranges from 16 to 20 feet.

Figures 31, 32 and 33 show the operation of the slide stack-

Fig. 32. The pusher collects the hay and carries it over the stacker. Long rollers are used on the pusher to reduce friction.

Fig. 33. Hay being delivered to the center of the stack by a slide stacker. Driving the pusher team fast or slow throws the hay to either side of the stack.
er. The hay is deposited by sweep rakes at the base of the stacker, then carried over the stacker by the pusher. Very little time, care, and accuracy are required in depositing hay at the stacker, compared to loading other types of stackers. If hay is slightly scattered when deposited at the stacker, the pusher has no difficulty in collecting it. By driving the pusher team fast or slow the hay may be thrown to either side of the stack. To return the pusher, it is carried back part of the way by its own weight, then the team is turned across the pusher pole, the double-trees turning on a swivel, and the pusher pulled back into a starting position. Two men are necessary on the stack even where labor is reduced by building stacks in sections.

The capacity of a slide stacker is about 10 tons per hour. The amount of hay stacked per man per day is about 6.9 tons, altho when eliminating mowing and raking, as high as 15 tons per man per day are stacked near Steamboat Springs where the yield is exceptionally heavy. The greater capacity and efficiency of the slide stacker are due to the following reasons: (1) Native hay is not bulky like alfalfa and can be conveniently handled in large quantities. (2) Sweep rakes need not make an extra push to load the stacker as is often the case with other stackers. (3) Less care may be exercised in handling native hay without danger of shattering. (4) Stack cribs are built to prevent waste by cattle, which assist greatly in building stacks. (5) The cooler climate enables a man or team to do more work.

The ordinary slide stacker has no adjustments except the

Fig. 34. A fan-shape stacker designed to carry the hay to either end of the stack.
lower apron may be turned up for transporting. Figure 34 shows a fan-shaped stacker designed to deliver the hay towards either end of the stack. The fan-shaped stacker is not entirely successful for the hay tends to follow the poles regardless of the direction the pusher is traveling. Figure 35 shows a stacker with an adjustable lower apron for transporting and an adjustable upper apron for extension as the height of stack increases.

Patent sweep rakes are used with slide stackers where the hay land is cultivated and smooth, but they are not strong enough to carry the heavy loads over rough ground, as is often found in North Park. Figure 36 shows the home-made North Park sweep rake. It has only two wheels, short teeth and is very heavily constructed. The rake is balanced by the operator who shifts his weight along the plank or platform extending to the rear.

The size and arrangement of crews where the slide stacker is used are similar to those given in Table 1, under overshot stackers, except a man is not used to operate the stacker. Where the hay is light and the acreage is large, as many as 6 mowers are run continuously throughout the haying season, with one man spending his entire time grinding sickles. A typical crew on
large hay ranches of 2,000 acres consists of 17 men and 30 horses—2 men on the stack, 3 men and 6 horses on sweep rakes, 1 man and 2 horses on the pusher, 4 men and 8 horses on sulky rakes, 6 men and 12 horses on mowers, 1 man as sickle grinder, and 2 relief horses.

*Cable Stackers.*—Cable stackers are used only on small ranches where the stack site is permanent near the barn or feed-lots. Figure 37 illustrates clearly the construction and operation of the stacker. The stacker is home-made and inexpensive. Either forks or slings are used. Very large stacks are built, insuring small losses.

*Hay Sheds.*—Hay sheds are used principally in La Plata county where very heavy rains and snows are common. Figure 38 shows a section of a typical hay shed. They are expensive and necessitate long hauls, but without them a large percentage of the hay would be lost in certain localities. Hay sheds are built sufficiently large to hold most of the hay, produced on the ranch, the size of the shed

Fig. 37. A cable stacker held in place by guys.

Fig. 38. A section of a typical hay shed used in the southwestern section of Colorado.
varying in length rather than width or height. Sheds are commonly boarded up several feet at the bottom forming a crib for the hay and protection against cattle and horses.

The size of the crew is the same as those mentioned under derrick stackers, page 26. Either forks or slings may be used but slings are preferred. The hay is carried on a track from the middle or end of the shed. Where the hay is loaded on wagons, hay loaders can be advantageously used. Assuming the same length of haul, more hay can be stacked in hay sheds than can be stacked by derricks, due to less labor or care in loading the slings and stacking the hay.

Hay sheds must be well constructed to withstand the heavy rains, snows and winds. They cannot be used profitably except under extreme climatic conditions, as will be discussed under "Protection of Hay."

**Rope Stackers.**—Rope stackers, although nearly replaced by modern stackers, are still used to some extent in the extreme southwestern section of the State. The stacker itself is simple, light, and convenient to move, but apparently a crude method of stacking hay.

Figure 39 represents the principle upon which the rope stacker operates. The hay is rolled onto the stack and may be deposited at any desired point. The amount of labor on the stack depends very much upon the condition of the hay. A special sling is carried on "Slips" or wagons. No adjustments are necessary with this stacker.

![Diagram of rope stacker](image)

**Fig. 39.** The principle upon which the rope stacker operates.
The rate at which hay may be stacked is about the same as for derrick stackers. Hay growers who have used the rope stacker, think it is a satisfactory method of stacking hay, but it is too slow. The size and arrangements of crews are similar to those given in Table 2, page 26.

**Baling Hay From the Windrow or Cock.**—Baling hay from the windrow or cock is practiced to some extent in a few sections of the State. Baling does not interest the man who feeds his hay or sells to alfalfa mills, but eliminates stacking for the man who exports or transports his hay. Figure 40 shows a modern power hay press in operation.

![Figure 40. A power hay-press for baling hay from the windrow, cock, or stack. (Courtesy of The International Harvester Company of America.)](image)

In order to successfully bale hay from the windrow, the climatic conditions must be favorable. If hay is not thoroly cured it is liable to heat or spoil. If it must be exposed long before thoroly dry, a percentage of the hay will be bleached or sun-burned. The rate at which hay may be baled from the windrow is 2.5 to 3.5 tons per man per day, which, being less than that handled by patent stackers, limits the use of the baler to a great extent. Successful baling of hay insures good quality, small losses and a saving of labor.

Baling hay from the stack is a very common practice and necessary in transporting hay any distance. Where a hay grower bales a part or all of his hay from the stack, he should investigate the possibilities of baling from the windrow which would be a great saving of labor and expense.

An efficient baling crew consists of 6 to 8 men—2 men on
sweep rakes, 2 pitchers, 1 feeder, 2 wirers and 1 off-bearer. Modern power presses have automatic feeders and block droppers which increase the capacity and reduce hand labor.

**Care and Storage of Baled Hay.**—Great care should be exercised in keeping bales dry in the field. If they are not hauled to the storage shed every day, they should be protected by some suitable covering such as loose hay or canvass. An emergency canvass or tarpaulin should be carried at all times, to be used in case of sudden rains.

Hay baled from the windrow should be stored in a manner which permits the circulation of air. Bales piled on edge a couple of inches apart with alternate layers crosswise insures a circulation of air through the entire pile, and greatly lessens the danger of heating.

**Hauling Hay Direct To Alfalfa Mills.**—Hay growers near an alfalfa mill haul all or a part of their hay to the mill, directly from the windrow or cock, thus eliminating stacking operations. While this is a great saving of labor it can affect only a few hay growers; the alfalfa mill has a limited capacity and cannot handle hay on a large scale and hay growers living some distance from the mill cannot spend the extra time for hauling during the haying season.

**Blower Stackers.**—A blower stacker has been detached from a grain separator and used successfully as a hay stacker in timothy hay, and mixed timothy and clover hay. (Figure 41.) This stacker has been operated in the vicinity of Colorado Springs

![Fig. 41. A blower stacker stacking timothy hay. A crew of two men, two horses, and a tractor stacking hay at the rate of 1.8 tons per hour. (6 tons per man per day is the average rate of stacking hay with the blower stacker.) No men on the stack, no stacker team or driver, and no stacker operator.](image-url)
for 3 years with no damage to stacks by wind or rain. Since
the stacker is power driven, and no men are required on the stack,
the number of men on the stacking crew is greatly reduced.

Hay is hauled to the stacker with sweep rakes, and pitched
by hand into a funnel-shaped feeder. The automatic rotating
device on the stacker distributes the hay. Stacks of about 20
tons are built. The amount of hay stacked per day is about 6
tons per man for a 3-man crew. The initial cost of such a stack-
er, with a source of power, and its possible shattering effects
on alfalfa hay, would prohibit its general usage under present
labor conditions.

Stacking By Hand.—Stacking by hand is a very slow, labor-
ious method and used only where the amount of hay is too small
to justify any investment in hay machinery. It is used in or-
chards and other places inaccessible by modern hay machinery.

INTRODUCTION OF MECHANICAL POWER

Mechanical power has been successfully applied to a few hay
stacking operations, but has not been used to any great extent.
The flexibility required in hay machinery and the cheapness of
labor, under present conditions, do not offer much encour-
agement for the use of power machinery except in a few instances.

Balers.—Perhaps the most successful appliance of mechan-
ical power has been with hay balers. (See Figure 40.) Power
balers are used extensively in Colorado but not at the time of
making hay, as discussed under "Baling from the Windrow",
page 32. The advantages of power balers when compared with
horse balers are: Continuous operation regardless of hot weath-

![Fig. 42. A double drum power hoist.](image-url)
er, higher capacity, less space required, and more economical per ton baled.

**Hoists.**—Power hoists are used to some extent; they eliminate the stacker team and operate the stacker or carrier faster than horses do. (See Figures 42 and 43.) Hay growers prefer horses to power hoists for the following reasons: (1) Horses are more flexible and reliable. (2) They operate the stacker as rapidly as desired by most crews. (3) It takes a capable man to successfully operate engine hoists but any child can drive a team. (4) The initial cost of a power hoist is greater. Power hoists are used to advantage with large crews who keep the stacker in continual operation or where horse labor is scarce.

**Mowers.**—Tractor mowers are used successfully on large ranches where tractors are used for other farm work, and have been quite advantageously used when labor was scarce. There is a greater saving of labor where one man can operate the outfit. The operation of tractor mowers has been discontinued almost entirely under present conditions, because of the drop in price of horse feed and the cheaper labor available for running horse mowers. See discussion of wide-cut mowers, page 5.

**Other Hay Machinery.**—Mechanical power has been used on sweep rakes in an experimental way, but, to the knowledge of this department, not on sulky rakes, side-delivery rakes, hay loaders, “slips”, wagons, or tedders.

**ORGANIZATION AND MANAGEMENT OF CREWS**

Both organization and management are controlling factors of the efficiency of a hay-stacking crew. Some crews stack only 50 percent as much hay as other crews of the same size, using similar machinery. Other factors which may affect the average
rate of stacking hay are: Kind of hay, yield of hay, length of haul, character of the land, climatic conditions, number of women or children, labor available, condition of machinery, care in stacking, and attitude of men. In general, crews are apparently well organized and managed for the conditions under which they work.

Inefficiency of capable crews is usually due to poor management. One man may retard the work of the whole crew; too much time may be taken at meal time or when some minor part breaks on a machine; men get to talking and arguing; the crew may be unbalanced, having some of the men idle a part of the time; or indifferent attitude of men and lack of "push" of the foreman may be causes of inefficiency.

**PROTECTION OF HAY IN THE STACK**

A thorough investigation has been made by this department in regard to hay losses and the feasibility of stack covers. The principal object of this investigation was to find an economical method of protecting hay in the stack, in order to meet the demands for good-quality hay, receive the higher prices offered for such hay, prevent losses, and to use less labor and care in stacking.

**Hay Losses.**—The percentage of hay lost without protection varies in different localities from 1 to 25 percent. The average loss for the entire State is about 7 percent as taken from a large number of estimates and personal observation. Important hay sections sustaining heaviest losses are La Plata and Morgan counties, and the southern part of Weld County. The feeding value of spoiled or discolored hay was not considered. Spoiled hay was assumed to be worthless. Heavy losses are due mainly to climatic conditions, but many times to insufficient care in stacking which is often admitted by the hay growers. Stacks in which the hay is poorly distributed and packed, absorb a large amount of moisture even after they are partly settled. Stacks with firm centers, hay well distributed and packed, and properly finished, will not absorb much moisture after standing a short time.

The importance of hay losses was brought forcibly to the attention of hay growers when prices of hay ranged from $20 to $35 per ton. Under normal conditions when average prices of hay are from $10 to $12 per ton, the farmer is not so vitally concerned about any expenditure to protect his hay.

**Feasibility of Permanent Stack Covers.**—Several types of permanent, demountable stack covers were designed with interchangeable sections, to be assembled on a stack of any length. The cost of painted corrugated iron, galvanized corrugated iron, and wooden covers were closely estimated and under 1922 prices vary from $85 to $109 for a 15-ton stack. Interest on investment
and depreciation give a yearly cost of $14.60 to $18.40 per 15-ton stack, to save a $12.50 loss of hay. Thus under present Colorado conditions, permanent stack covers are impractical except in a few extreme cases where hay sheds have been built.

Natural Means of Protection.—Some natural means of protecting hay in the stack are:

1. A covering of green hay, which holds its leaves, cures, packs closely and sheds much moisture.
2. A covering of slough grass or other heavy grasses which shed rain.
3. Special care in building stacks, keeping center full, hay well scattered and packed, and a full, round top.
4. Finishing the stack by raking off loose hay, smoothing sides and combing the stems downward allowing easy drainage of moisture.

In sections where rains are common during the stacking season, a canvass or tarpaulin should be carried as an emergency cover for open stacks.

RULES FOR MEASURING HAY

The measurement of hay in stacks cannot be done accurately because of the variations in the shape of stacks and the weight per unit of volume. The rule universally used and apparently quite accurate, is the U. S. Department of Agriculture rule quoted from circular No. 67:

\[ \text{Volume} = F \times O \times W \times L \]

where \( F \) represents a fraction varying from .25 to .37, depending upon the shape of the stack as shown in Figure 44, \( O \) the over measurement or distance over the stack from the base on each side, \( W \) the average width, and \( L \) the average length.

To find the volume of a stack in cubic feet, first determine the value of \( F \) by comparing the shape of the stack to the cross-section in Figure 44. If the cross section of the stack is between two shapes given in the figure, an intermediate value of \( F \) may be used. Multiply the chosen value of \( F \) by the \( O \)ver in feet, that product by the width in feet and the last product by the length in feet.

To find the number of tons of hay in a stack, divide the volume by the number of cubic feet per ton. The following table gives an approximate number of cubic feet of hay per ton after settling under Colorado conditions.

<table>
<thead>
<tr>
<th>Days</th>
<th>Cubic Feet per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>560</td>
</tr>
<tr>
<td>60</td>
<td>540</td>
</tr>
<tr>
<td>90</td>
<td>512</td>
</tr>
<tr>
<td>120</td>
<td>485</td>
</tr>
<tr>
<td>Late winter</td>
<td>450</td>
</tr>
</tbody>
</table>
Fig. 44. Cross sections of different shaped hay ricks and the corresponding fraction (F) to be used in the formula for volume. (Reprinted from Circular No. 67, U. S. Department of Agriculture.)

Native hay packs together more closely than any other hay and 422 cubic feet of it is considered a ton.

The kind of hay and conditions at the time of stacking may produce slight variations in the figures given in the above table.

Example: A hay rick is 20 feet wide, 36 feet long and the over is 40 feet. The end view indicates that the shape of the rick is very close to No. 4, Figure 44. If the rick has settled for 60 days, how many tons of hay does it contain?

Solution: Volume = .28 x 40 x 20 x 36 = 8,064 cubic feet
Volume ÷ cubic feet per ton = No. of tons
8,064 ÷ 540 = 14.9 Tons of hay in the rick.
SUMMARY

Hay is the most valuable crop grown in Colorado and gives the farmer the most uncertainty in proper harvesting. Alfalfa is the principle kind of hay and should be cut at the beginning of bloom or when new shoots appear at the crown. Irrigating should be done a sufficient number of days before cutting to allow the ground to become firm.

Curing hay in the swath and windrow is a fast method, produces good-quality hay and requires little labor. Curing in the cock is slow and expensive but produces a superior quality of hay. Curing in the swath is not practiced except in timothy hay or grasses in cool, dry weather. Curing in the stack, if partly cured before, produces a palatable hay for sheep or cattle, known as “stack-burnt” hay. Hay is cured if moisture does not appear when a wisp is twisted in the hands.

A comparison of the methods of stacking hay indicates: The overshot stacker is extensively used, light, fast, builds stacks with firm, full centers, but requires much labor on the stack. The swinging stacker is similar to the overshot except labor is reduced on the stack and stacker but there is more liability of building stacks less resistant to water. The combination is best adapted to small crews, greatly reduces labor on the stack and stacker, approaches any side of the stack, but has a low limit of elevation, is heavy for an average team and more liable to build stacks less resistant to water. The derrick is cheap, heavy, slow. builds large stacks and insures good-quality hay. The slide is cheap and has the highest capacity but is adapted only to conditions similar to those found around North Park. Cable stackers, hay sheds, rope stackers, baling from the windrow or cock, hauling direct to alfalfa mills, blower and hand methods are used only under particular conditions. Mechanical power has been introduced successfully into baling, hoisting, and mowing under conditions favorable for each.

Hay losses are comparatively small in the State as a whole and permanent stack covers are not practical except in extreme cases.

Rules for measuring hay give only approximate results and vary greatly on different shaped stacks.