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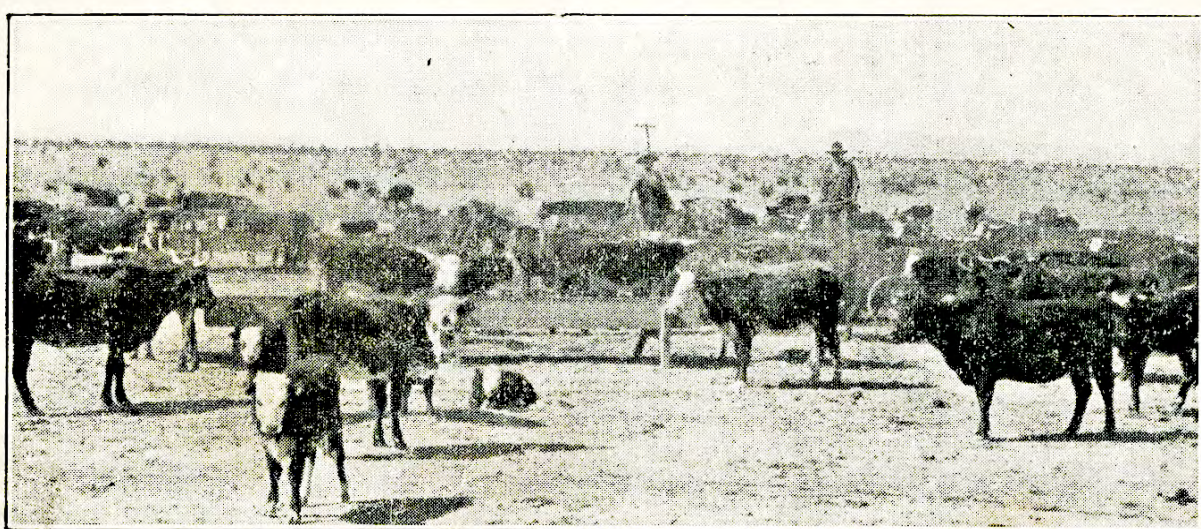
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**NEW MEXICO COLLEGE OF AGRICULTURE
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JORNADA EXPERIMENTAL RANGE,
BOX 871, LAS CRUCES, NEW MEXICO
Agricultural Experiment Station
State College, N. M.



Feeding Yucca on the Jornada Range Reserve

Range Cow Maintenance on Yucca and Sotol

BY LUTHER FOSTER AND CLEVELAND W. HUMBLE

Range Cow Maintenance on Yucca and Sotol

Introduction

OWING to the overstocking of the ranges and the not infrequent drouths of the Southwest, stockmen in this region have for years been seeking some native plants, inured to the climate not ordinarily considered a stock food that would help out these conditions. The experiments in this direction have already shown the value of some varieties of the cactus for this purpose. The investigations of this Station, conducted by Professor R. F. Hare a number of years ago, both at this institution and at San Antonio, Texas, in co-operation with the United States Department of Agriculture, showed the composition, digestibility and food value of the cactus, and developed new methods of handling and feeding it. The results of this investigation are published in Bulletin No. 60, "Prickly Pear and Other Cacti as Food for Stock," by D. Griffiths and R. F. Hare.

While the cactus is widely distributed, it does not grow in sufficient quantities, except in very limited areas, to make it generally available for stock feeding. Then, too, it is quite difficult to handle and prepare for feeding, excepting on the land where it grows.

Sotol has also been quite extensively and successfully used for feeding in localities where it grows abundantly.

Further search for a range grown food that produces more abundantly than the cactus, and, at the same time, has a more extensive distribution, called attention to the possibilities of the different varieties of the Yucca; more particularly to the one commonly known as Amole or Soapweed (*Yucca elata*). Stockmen have long considered this an important plant on the range. At certain periods of the year, when the bloom stalks are growing, the cattle live on them, eating the stalk in preference to other forage. Often range cattle have been maintained almost wholly on these stalks through the period which they lasted. It was noticed, too, that they came to the watering places less frequently

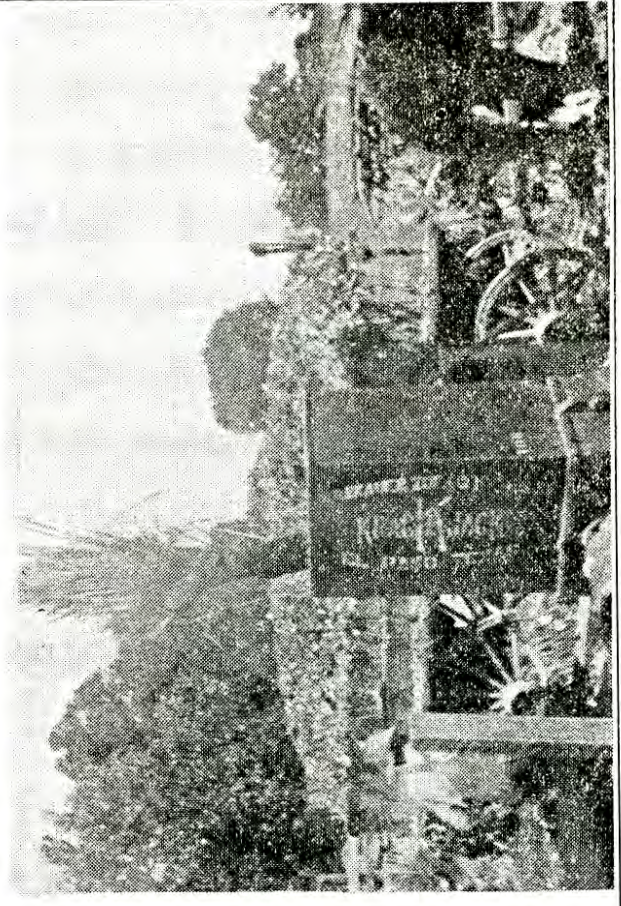
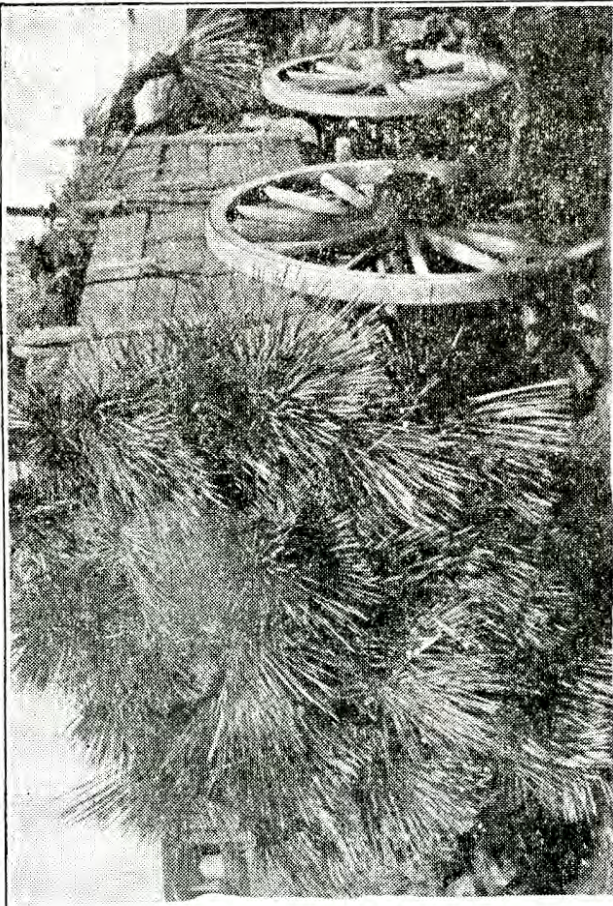


Fig. 1. *Yucca elata* before and after cutting.

while feeding on the Yucca. These facts, taken in connection with the chemical analysis of the plants, indicated their succulence and food value, and were instrumental, to a large extent, in the inauguration of the experiment.

A few years ago Mr. C. T. Turney conceived the idea of making use of the whole Yucca plant for feeding at times when the range was short. He constructed a pit silo on his range and filled it with Yucca, about three years ago, but did not feed it out until recently, when it was found to be in good condition, and the cattle ate it with relish. When the drouth came on last season it was very largely through Mr. Turney's efforts that a suitable machine was manufactured for cutting this plant at moderate cost and putting it in shape so that cattle could readily eat it.

The value of Sotol heads for cattle feeding is generally pretty well known. It is readily prepared for feeding, and has been quite generally used in western Texas to supplement the range when other feeds were scarce. Its compact head and general appearance gives better indications of food value than that of the Yucca. It was, therefore, included in the experiment as a means of comparison. It is not nearly so important a plant as the Yucca, because of its less wide distribution, being found, as a rule, only on the foothills and slopes near the mountains, while the Yucca is pretty generally distributed over the mesas extending from the valley to the mountains over such areas as seem adapted to it.

Yucca elata (Soapweed) is the variety used in this experiment; but, judging from analysis recently made, it is believed that the *Yucca macrocarpa* (Spanish Dagger) will prove equally good, and it is distributed practically over the same area as the *elata*, and is often mixed with it. Another species of this plant, known as Bear Grass (*Yucca glauca*), has also been used for cattle feeding to some extent in the eastern portion of the State, where it is plentiful.

DESCRIPTION OF YUCCA SPECIES AND SOTOL

The following descriptions of these plants are taken from Bulletin No. 87 of this Station, which was written by Professor E. O. Wooton, formerly Botanist of this institution.

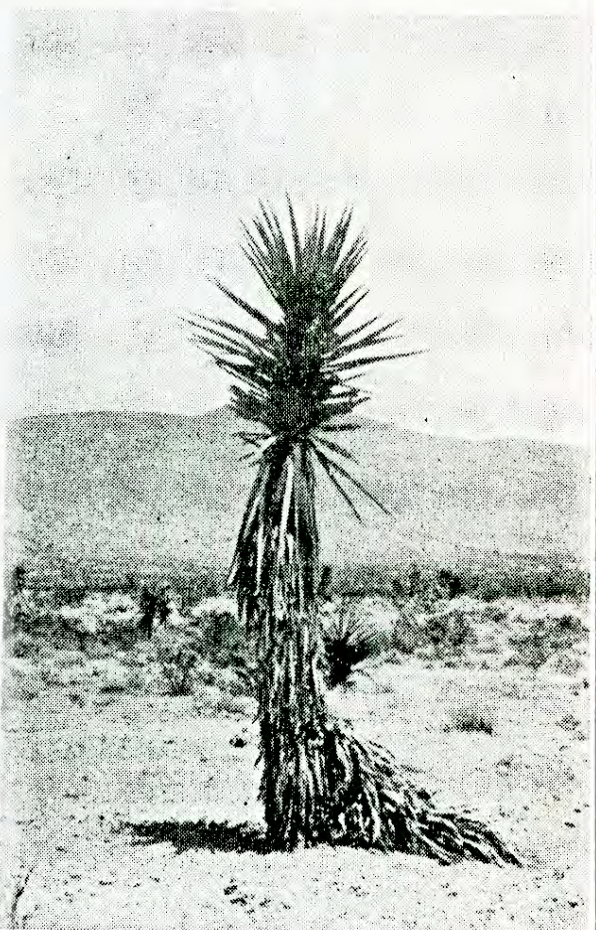
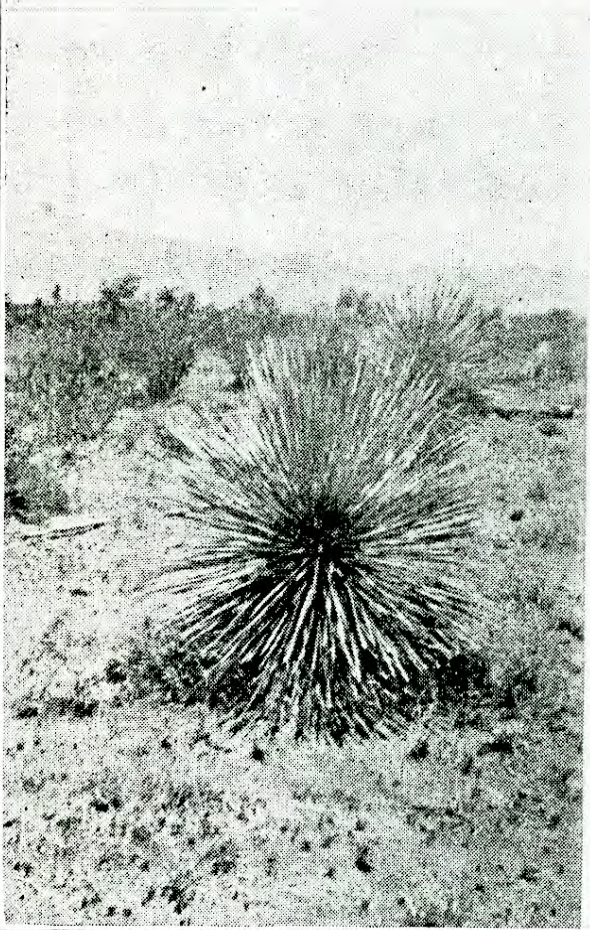
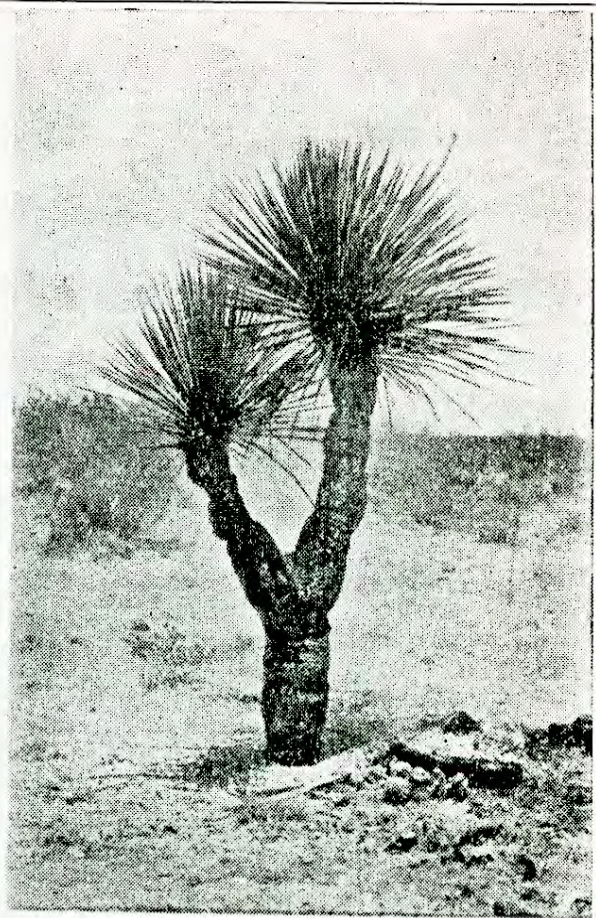
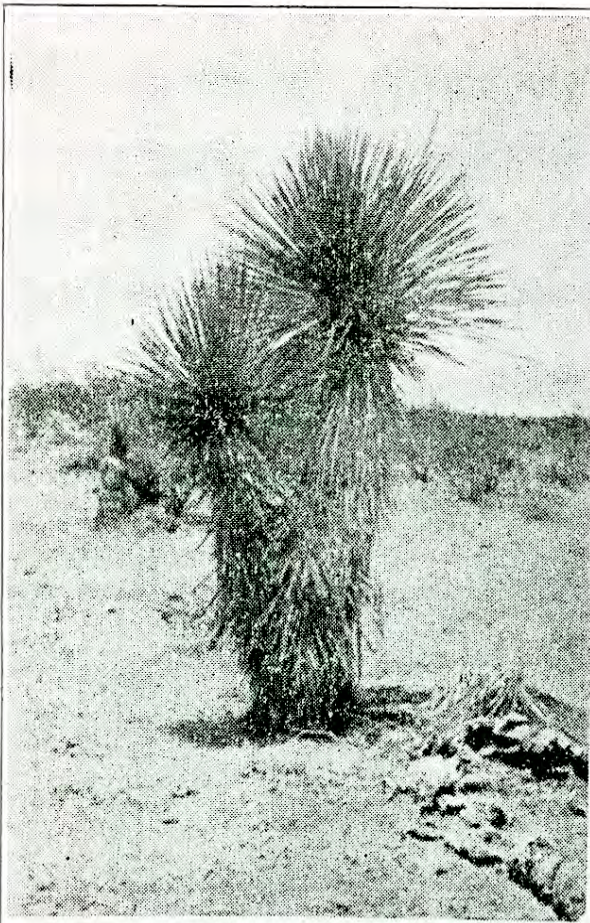


Fig. III. Yucca before and after burning.
Yucca too small to cut and Spanish Dagger.

Soapweed, La Palmilla, Amole (*Yucca elata*). This is the tall, narrow leaved species of Yucca. Its leaves are slender (half an inch wide or less), flexible, and very numerous; its flower-stalk is much taller, its blooms make a better showing than the other varieties, and its stem is more often branched. Its stems are conspicuous (except in young plants), reaching a height of 10 to 15 feet in old plants, often several together in a cluster, simple or branched. Its leaves are in a cluster at the top, the lower ones reflexed; old dead ones sheathing the stem almost to the base. Its flower-stalk is a tall, widely spreading panicle 6 to 10 feet high, with numerous flowers, usually ivory white.

Spanish Bayonet, Spanish Dagger, La Palma (*Yucca Macrocarpa*). This is the broad and stiff leaved species which is common on the mesas in the southern part of the State. Ordinarily it has a straight stem six to eight inches in diameter and four to eight feet high, with a head of stiff, spreading leaves about four feet in diameter at the top. Under favorable conditions this plant will reach a height of 18 or 20 feet. The stem is usually simple, but sometimes it branches either at the base or some distance from the ground. The leaves are rigid, rough like shagreen, yellowish green, not glaucous; filaments coarse and grayish.

Bear Grass (*Yucca glauca*) is exceedingly common in the eastern part of the State; and on much of the land now used as dry land farms it was necessary to grub these plants out. By the residents it was considered as an undesirable weed. It resembles the soapweed very closely, but is almost stemless and the panicle of flowers is shorter and much less branched.

Sotol (*Dasyllirion wheeleri*) is a perennial, with flat strap-shaped leaves having numerous recurved slender teeth along the margin. The trunk is usually 6 or 8 inches in diameter and from 1 to 4 feet tall, and covered by the dead leaf bases of older leaves. The leaves are very numerous and flexible, forming a thick crown at the head of the stem. The flowers are very small and numerous, borne in panicles on a tall stalk, often several feet high. It is a near relative of the Yucca and is usually found more or less associated with it. It usually grows among the rocks on the foothills and mesas, near the mountains.

The bases of the leaves form a round head (when the ends have been cut off), which has been used extensively for stock feeding in western Texas. These heads are roasted by the native people and used for food, and for the manufacture of a drink, also called Sotol, which contains from 40 to 50 per cent of alcohol.

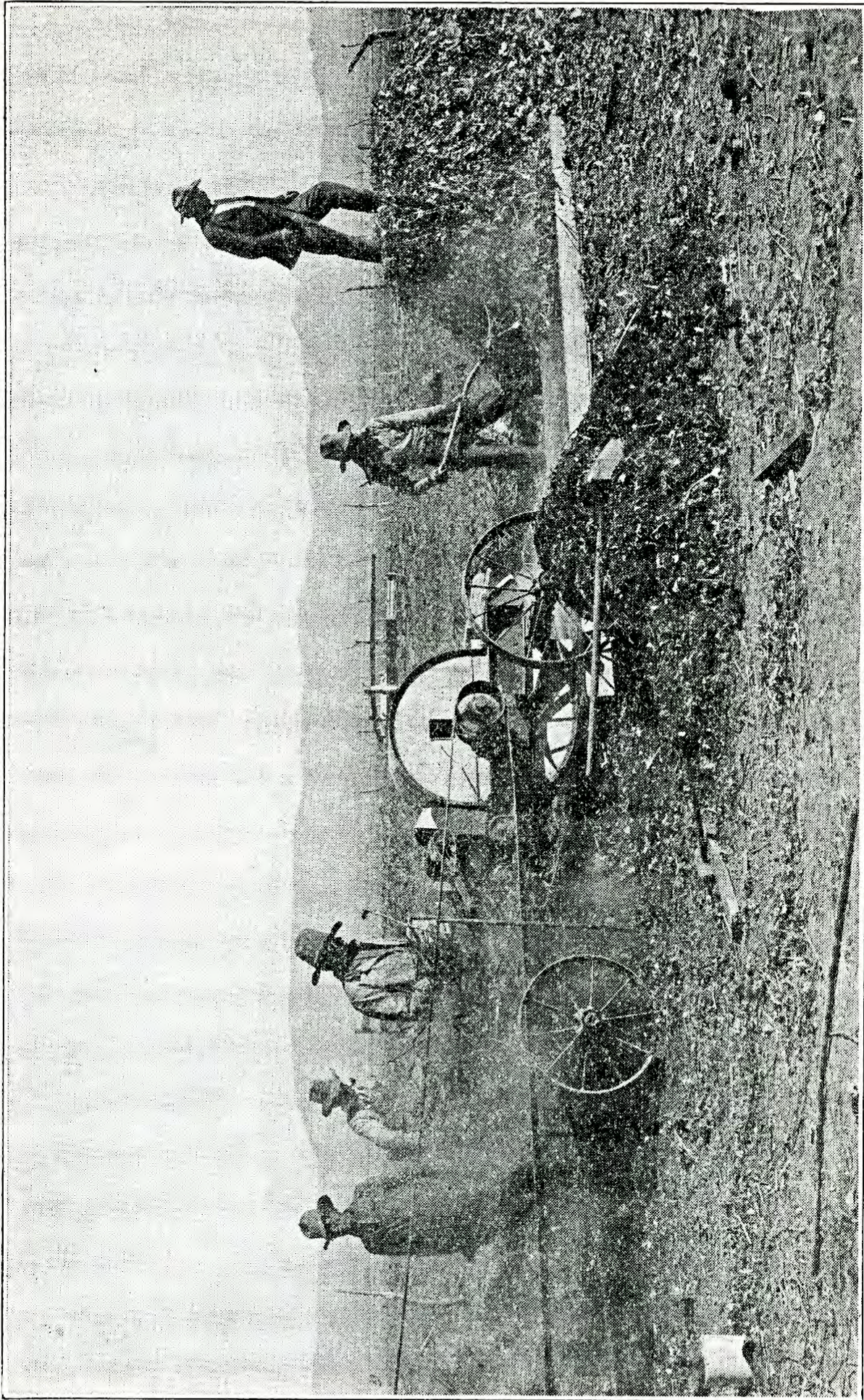


Fig. IV. The large type Yucca cutter in action.

Plan of Experiment

The object of this experiment was to determine the value of Yucca and Sotol for maintaining range cows through periods of drouth like that just past, when the ranges are either bare or very short of anything upon which cattle may graze.

For this feeding test twenty-five range cows in thin condition from two to four years old, were selected. Five of them had calves by their sides when the experiment began. The other twenty were divided into four equal lots, one of which was fed 25 lbs. per head daily of Sotol heads, which was later increased to 30 lbs.; another the same quantity of Yucca. The other two lots were fed exactly the same as the preceding two, with the addition of 2 lbs. of cottonseed meal per head daily, but with no increase in the quantity of Yucca or Sotol. The five cows with calves were made a separate division, and were given 25 lbs. of Yucca and 2 lbs. of cottonseed meal per head daily, throughout the test. The calves were allowed the run of a separate lot, where they were given a small allowance of Yucca and cottonseed meal, which was gradually increased until the cottonseed meal reached one-half a pound per head, with about all the Yucca they would eat. Ten additional calves were dropped during the experiment, which were also given the run of the calf lot as soon as old enough to eat, and the quantity of feed was increased proportionately.

The lots contained five cows each, and were arranged and fed as follows:

Lot I. Sotol heads, 125 lbs. daily.

Lot II. Sotol heads, 125 lbs. daily and 10 lbs. of cottonseed meal.

Lot III. Yucca (Soapweed), 125 lbs. daily.

Lot IV. Yucca (Soapweed), 125 lbs. daily, and 10 lbs. cottonseed meal.

Lot V. Cows with calves by side, fed the same as Lot IV, 125 lbs. of Yucca daily and 10 lbs. of cottonseed meal.

PREPARATION FOR FEEDING

During the first few weeks of the experiment both the Sotol heads and the Yucca were prepared for feeding by chopping them up into coarse pieces with an axe and then running the pieces through an en-

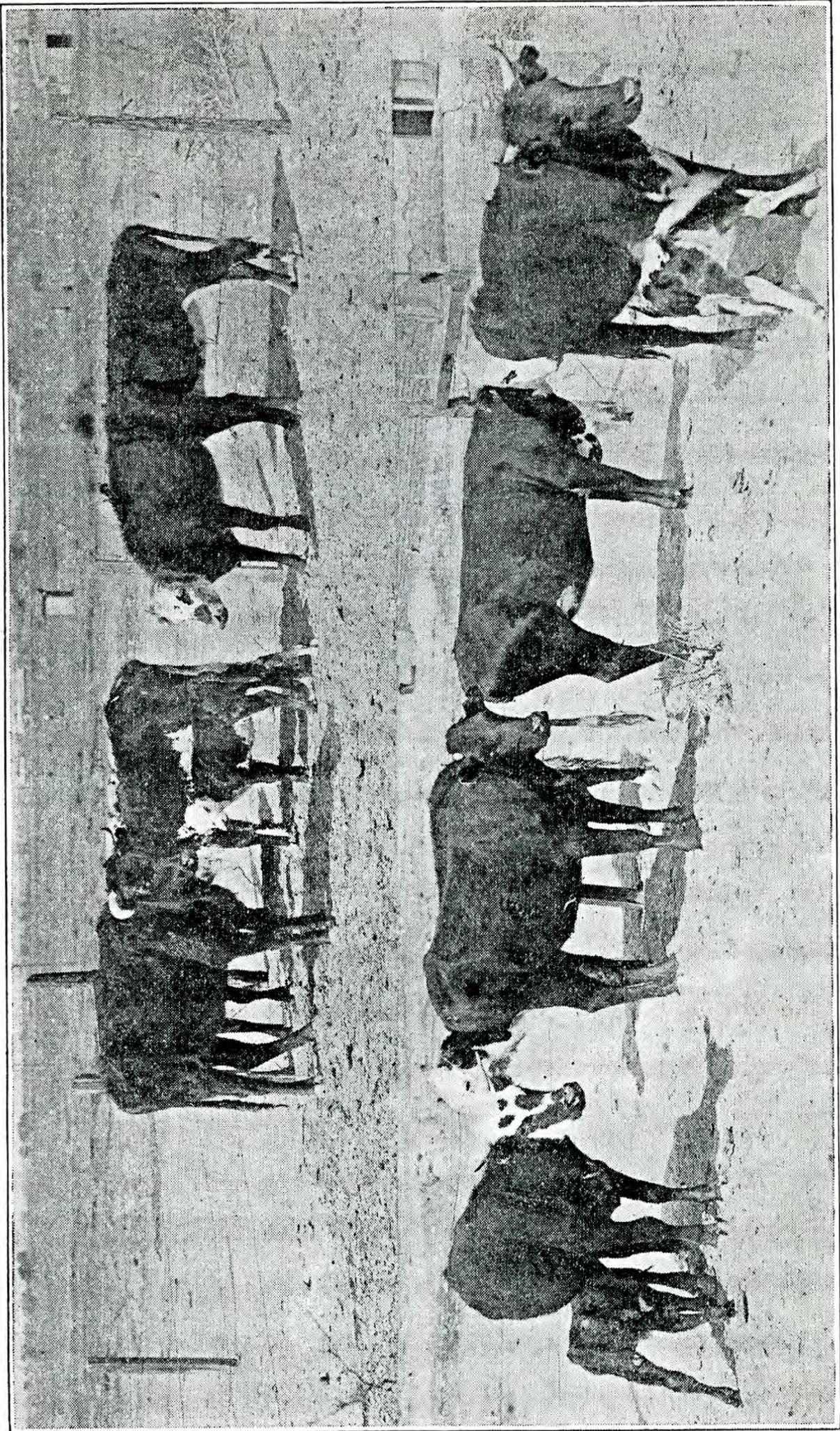


Fig. V. Sotol lots with and without cottonseed meal.

silage cutter. This preparation put the plants into good condition for feeding, but the process was too expensive to be practical. As soon as the new machines, designed especially for cutting the Yucca, were ready for use, one from each of two factories was contributed for demonstration and use in the experiment. Both of the machines did excellent work, cutting and shredding the stems and heads sufficiently fine for the cattle to eat them with very little waste; and they reduced the expense of cutting to a comparatively small item. The power used for running these machines was a 15 H. P. electric motor that had been installed at the College Farm some years ago for the cutting and grinding of feed.

Four different kinds of machines have been manufactured during the past year for the purpose of cutting up and preparing Yucca for feeding. Two of them were made in El Paso, Texas, and two in Deming, New Mexico. All of them did very good work, the general idea of all being the same—to prepare the Yucca so that it can be fed with little waste. Three of them had a tendency to cut and shred the plant at the same time, while the other one simply cut the stem into thin slices and broke them up into fine particles. But the quantity rejected by the cows did not differ materially because of the different methods of preparation.

In preparing the Yucca for cutting the dry leaves were burned off of the stem of the plant where it grew on the mesa. It was then cut off at the ground, the stem furnishing the most important part of the feed. The green leaves of the top were not eaten with the same relish as the slices of the stem unless cut up fairly fine.

Only the compact head of the Sotol was used, the stem and leaves being cut off close to it. The brown, dead-looking leaves of the lower part of the head were also trimmed off.

HOW FED

In feeding the Yucca and Sotol, long, deep troughs were used; and where cottonseed meal was fed with either, the Yucca or Sotol was spread over the bottom of the trough and the meal was sprinkled over it. The cows were fed once daily, just before noon. They were eager for this feed from the first, and ate it with, seemingly, great relish. The cows used in the experiment were already familiar with cottonseed meal, but cattlemen in this locality who fed Yucca and cotton-

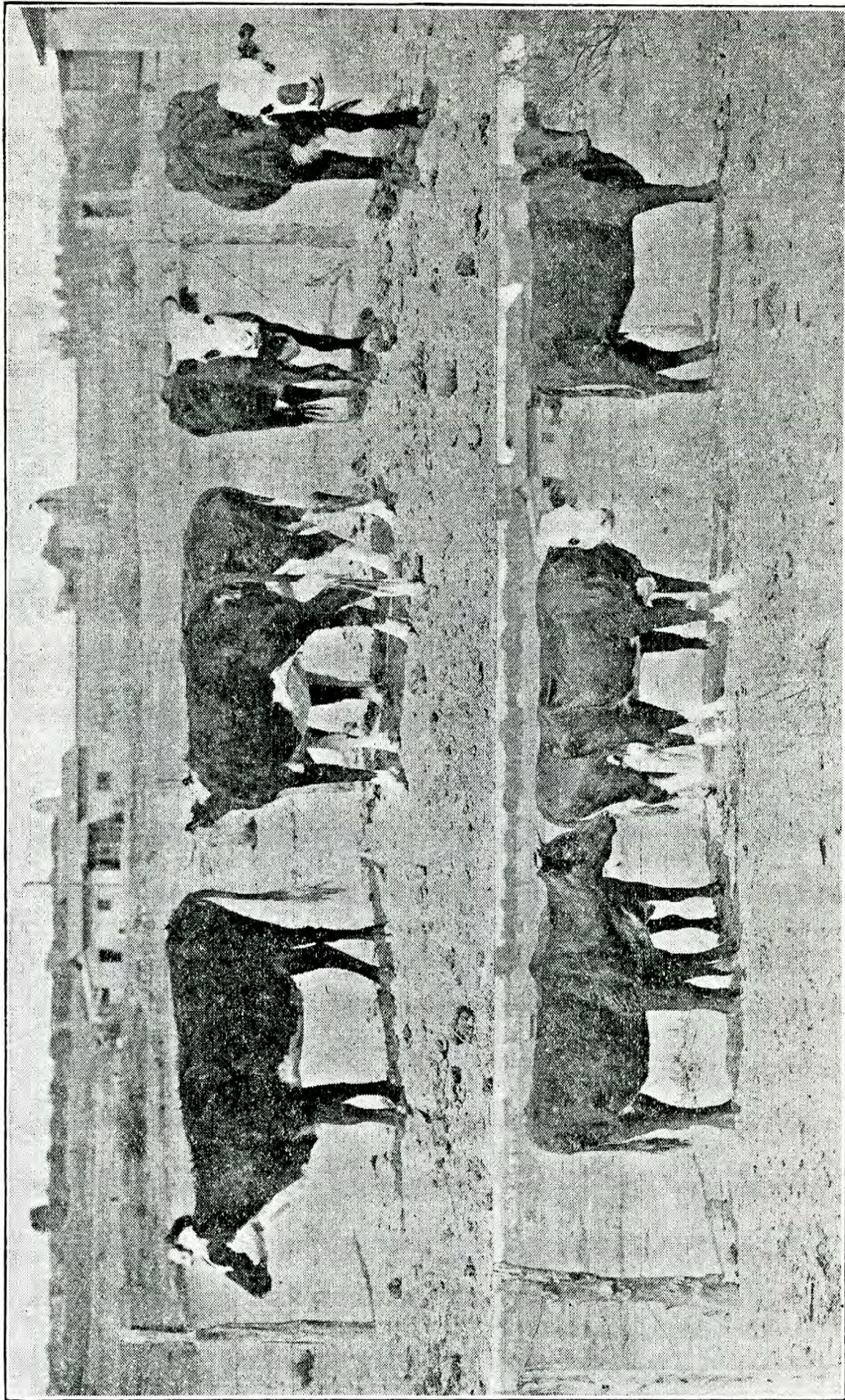


Fig. VI. *Yucca elata* lots with and without cottonseed meal.

seed meal during the past winter, suggest that a good way to teach the cows to eat cottonseed meal is to sprinkle it over the Yucca. In that way they eat it from the beginning, while it often takes several weeks to teach them to eat it when it is fed alone.

In addition to the feeds mentioned, the cows had the run of about fifty acres of brush pasture, consisting of what is known as *chamiso* or shadscale brush, with a few mesquite and creosote bushes scattered through it. In the beginning, when the Yucca and Sotol had a tendency to physic the cows, they ate the dry leaves and seeds of the brush quite freely, which had a tendency to counteract the loosening effect. This brush also had a tendency to satisfy their craving for dry feed, after the abrupt change from the very dry feed of the range to such succulent feed as the sliced Yucca made. It was the intention to make the conditions similar to those of the range, where the cattle would have some dry weeds, or grass in connection with the Yucca or Sotol. This brush pasture was pretty well eaten off within the first six weeks of the experiment, but later on in the season the cows were herded about three hours every day on a similar unfenced pasture, to determine if the seeds and leaves of this plant have any special food value or effect in maintaining the cows. There was a constant supply of water and salt in the pasture, to which the cows had free access.

These cows were put on feed December 11, and during the first month, when no regular machine was available for the preparation of the feed, all lots were fed Sotol about half the time, because it could be more readily prepared. The regular experiment did not begin until January 12, when each lot was confined to the special feed it was to have as shown by the outline of the experiment. No cottonseed meal was fed to any of the lots up to that time.

The following table* shows the weights from time to time of the different lots of cows and the calves, from the fifth lot, during the experiment:

WEIGHTS OF COWS AND CALVES

		Preliminary Period in Corrals					Calves	
Date		Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 5	
		Sotol Only	Sotol and Cottonseed Meal	Yucca Only	Yucca and Cottonseed & Meal	Yucca and Cottonseed Meal	Yucca seed	Yucca Ctn-Meal
First weights	-----Dec. 11	3195	2995	3035	3015	2705		
Last weights	-----Jan. 12	3250	2995	3035	3140	2725		
Gains	-----	55			25	20		

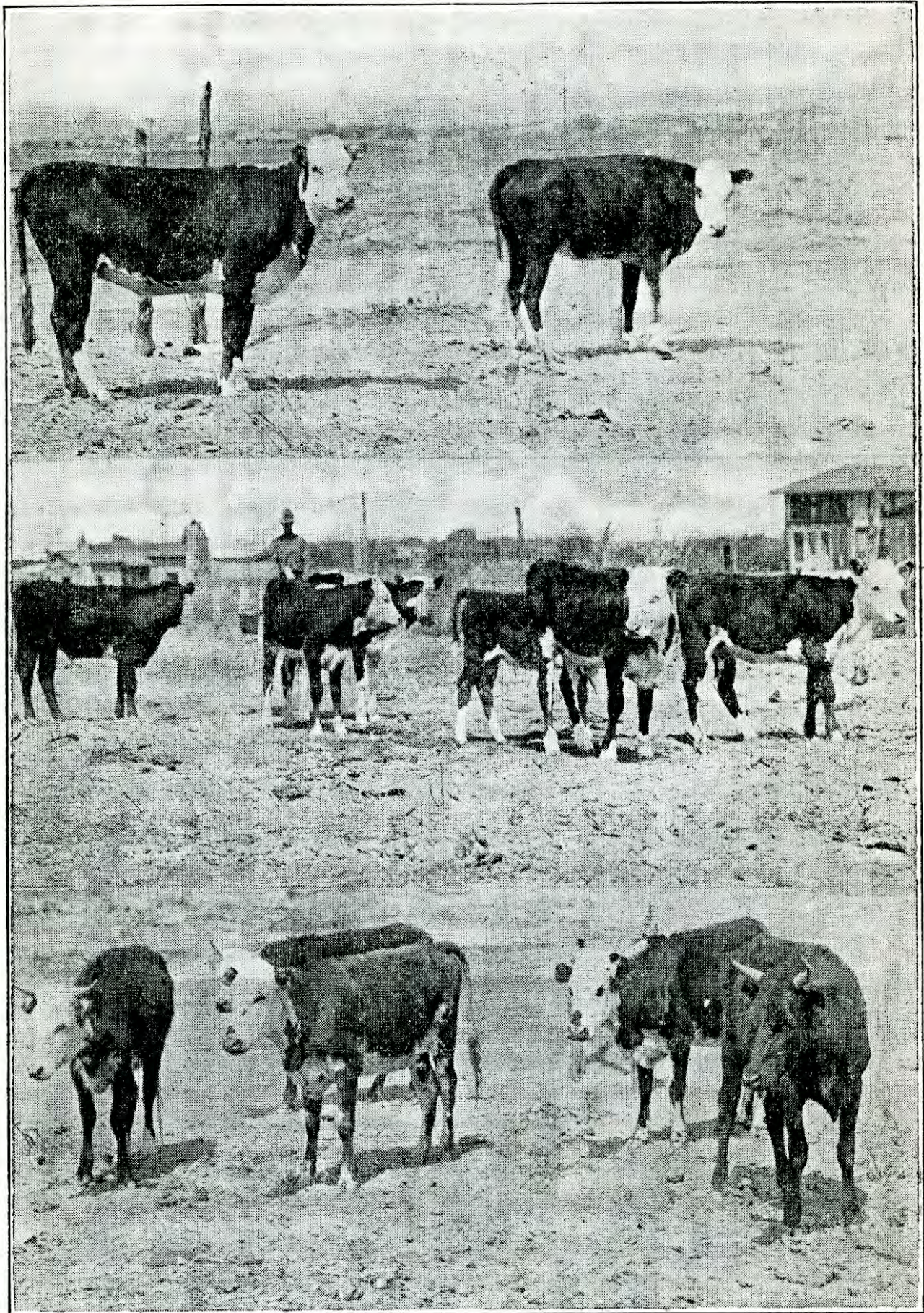


Fig. VII. Two cows without calves from Lot IV
Calves from Lot V and their Mothers.

First Period, on Brush Pasture

Beginning weights-----	Jan. 12	3250	2995	3035	3140	2725	515
	Feb. 12	3190	3265	3120	3545	2940	685
	Feb. 26	3215	3350	3115	3520	2905	745
	Mar. 12	2960	3245	3060	3460	2975	830
	Mar. 19	2937	3340	3020	3440	2950	885
	Apr. 2	2985	3290	2990	3425	3060	975
	Apr. 16	3060	3455	3060	3530	3045	1085
	Apr. 30	3075	3425	3020	3465	3050	1105
Ending weights-----	May 7	3060	3325	3055	3420	3005	1245
		190	330	20	280	280	730

Second Period, in Corrals

		5	3	5	3	5	5
		cows	cows	cows	cows	cows	calves
Beginning weights-----	May 7	3060	1888	3055	2100	3005	1245
	May 21	2880	1790	2945	1950	2990	1300
	May 28	2975	1810	2915	1900	2945	1350
	June 13	3180	2340	2950	1830	2930	1490
Final weights-----	June 25	3150	3000	2900	3220	2860	1500
		10	325	155	200	145	255
	Number of Calves-----	1	3	4	2	5	

NOTES ON TABLE

Lot I, fed on Sotol alone, and Lot III on Yucca alone, were carried on these feeds through the entire experiment without interruption, from January 12 to June 25. A very thin cow of the Sotol lot raised the only calf that came to that lot, but it was found necessary to feed her two pounds of the cottonseed meal per day for 38 days to keep the calf growing and put the cow in condition to live on Sotol alone.

Four calves were raised by Lot III, the cows having no other feed than the Yucca. Considering the fact that the first weights of the cows were taken before these calves were dropped, and the final weights without them, one may safely conclude that the cows were fully maintained during the 6½ months' feeding trial.

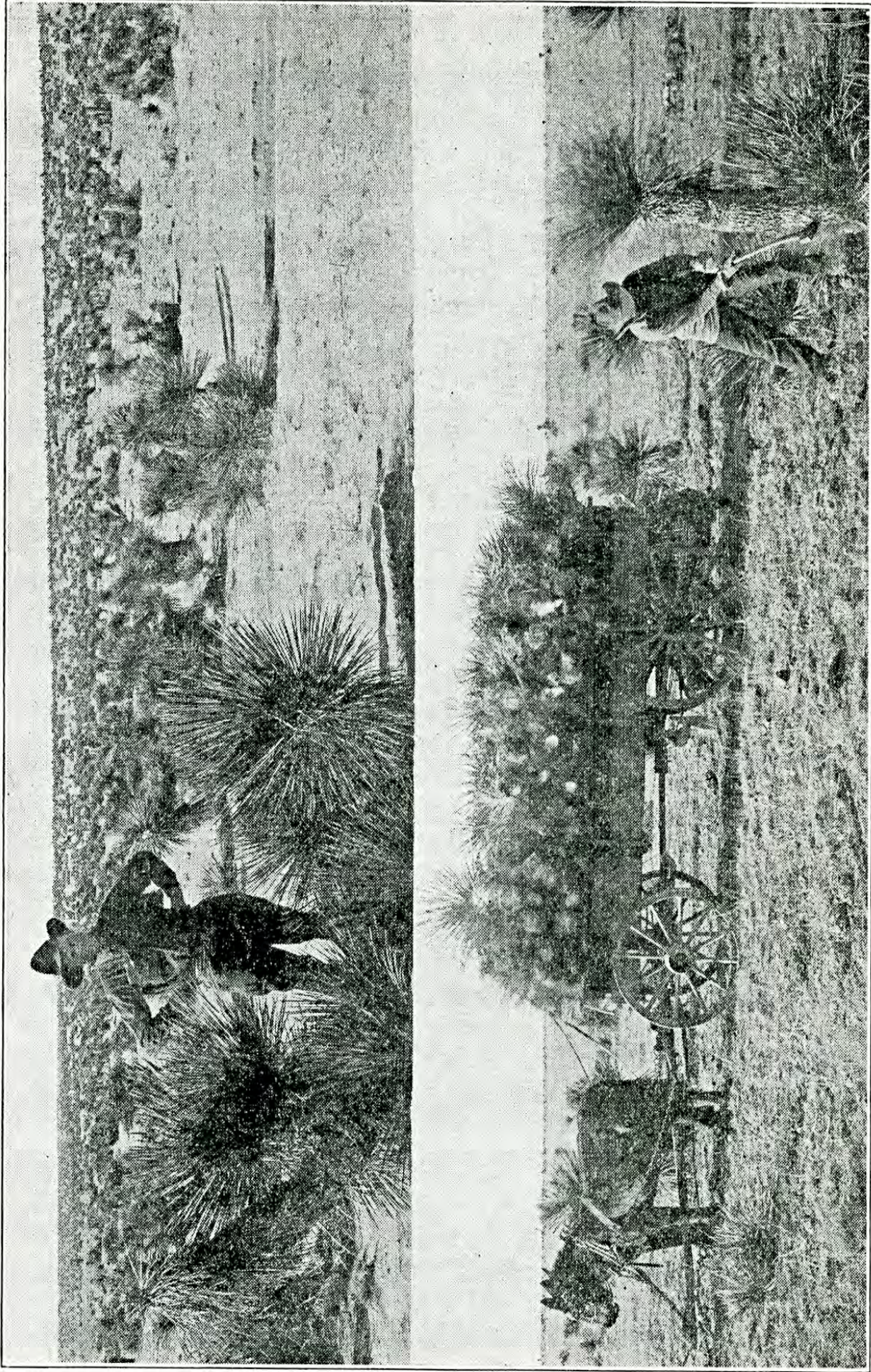


Fig. VIII. Native field of Yucca. Method of cutting and loading.

Lot II, fed Sotol and cottonseed meal, and Lot IV, fed Yucca and cottonseed meal, were not only maintained but made very good gains during the first period; but in readjusting the experiment for the second period, two cows were taken from each of these lots for a digestion test, and they lost quite heavily from the close confinement and the withholding of the cottonseed meal. They were returned to their respective lots a short time before the final weights were taken.

All the cows of Lot V had calves when they came in from the range, and they not only raised their calves, but also improved much in condition during the first period; but during four weeks of the second period they were fed on Russian thistle silage without cottonseed meal, which accounts for their loss in weight.

It will be seen that the calves gained steadily all through the experiment, except at the very last, when their supply of milk was likely lessened by the change made in the feed of their mothers.

The whole quantity of feed given Lot I from December 11 to June 25 consisted of 1600 pounds of Yucca, 25,475 pounds of Sotol and 76 pounds of cottonseed meal.

Lot III had, during the same time, 25,475 pounds of Yucca, and, in addition, during the preliminary period, 1600 pounds of Sotol.

Lot V was given, during the same time, 20,650 pounds of Yucca, 3,775 pounds of Russian thistle silage and 1600 pounds of Sotol, in addition to 1150 pounds of cottonseed meal.

The five calves of Lot V were fed by themselves from January 12, and they were given 6670 pounds of Yucca and 536 pounds of cottonseed meal. The extra gains that were made, apparently from this extra feed, would no doubt well repay the outlay.

Composition and Digestibility

Professor J. D. Hungerford, the Nutrition Chemist, determined the composition of *Yucca elata*, *Yucca macrocarpa* and Sotol heads. He also ran a preliminary digestion experiment to determine the digestibility of the *Yucca elata* and Sotol heads as used in the feeding experiment. The following table gives the results of the work:

PRELIMINARY DIGESTION TRIAL.

Composition in percentage.

	Air Dry		<i>Carbohydrates</i>				
	Matter	Moisture	Ash	Protein	Fiber	N. Free Extract	Fat
Sotol -----	26.00	4.90	4.53	3.59	25.00	59.59	2.39
Yucca elata-----	42.69	5.29	8.11	3.95	30.93	50.69	1.02
Yucca macrocarpa ---	32.8	5.58	7.46	4.69	32.84	48.13	1.30

Coefficients of Digestibility.

Sotol -----	39.68	35.50	81.05	2.81
Yucca elata -----	34.81	38.81	74.63	.00

Digestible Nutrients in 100 pounds of Fresh Material.

Sotol -----	.37	2.31	12.56
Yucca elata -----	.59	5.21	16.15

These analyses are reported on an Air-Dry Matter basis.

While this work is only preliminary, it gives a very good idea of the digestibility of these plants, and the results compare quite favorably

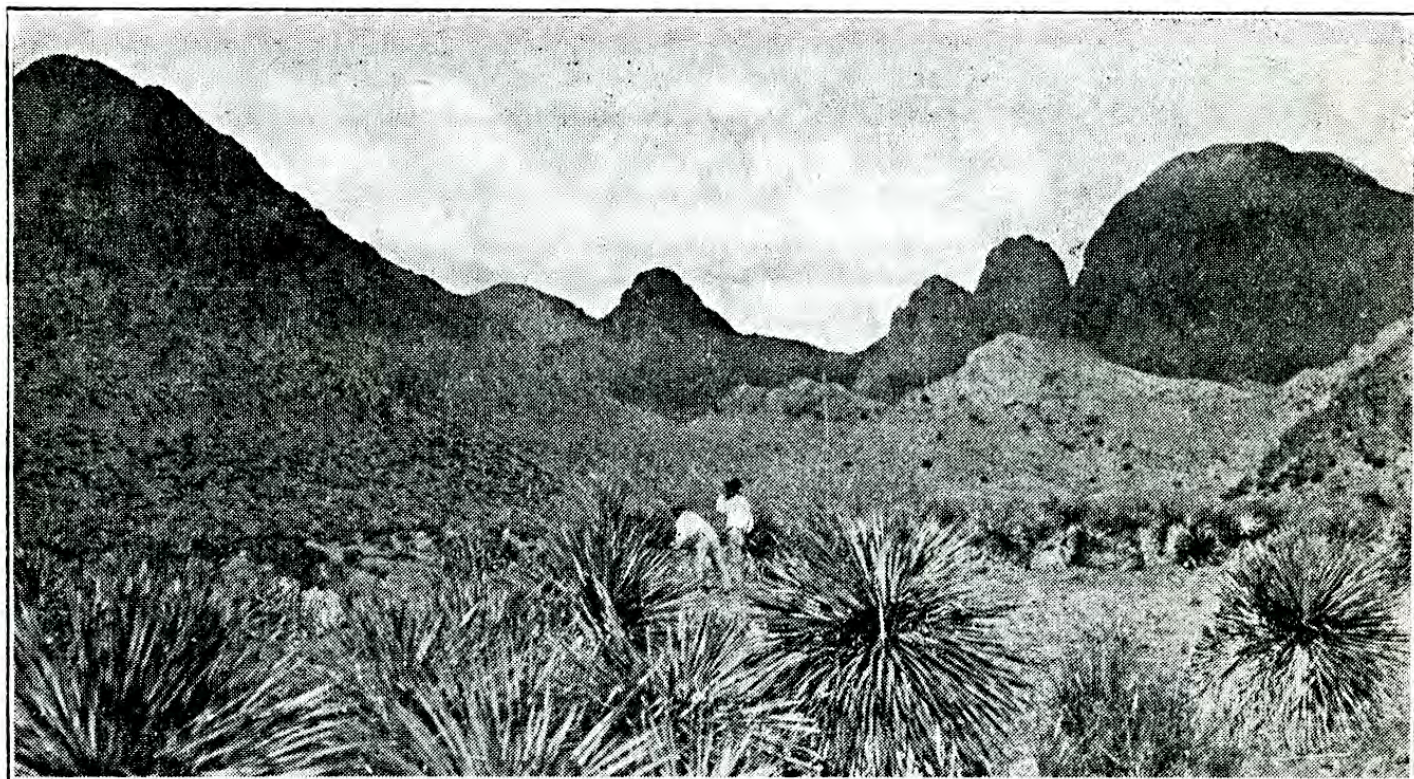


Fig. II. Mountainside of Sotol.

with our estimates published in Press Bulletin 301. These estimates were made from the digestibility of corn fodder, as reported in Henry's "Feeds and Feeding." It will be noticed that the coefficient of digestibility of fat is in either case practically zero. No explanation will be attempted for these until after further investigation.

Although no very complete investigation of the carbohydrates of plants of this nature has been made, it has been noticed that they are largely composed of simple sugar and therefore readily available.

Further study is now being made at this Station of the feeding value and digestibility of *Yucca elata*, and the results will be reported in the near future.

Feeding Yucca on the Jornada Range

The following report of the system followed in feeding Yucca to cattle on the range, and the cost of the same, was furnished by Mr. C. L. Forsling, who is in charge of the Jornada Range Reserve:

COLLECTION, PREPARATION AND FEEDING OF SOAPWEED UNDER PRACTICAL RANGE CONDITIONS ON THE JORNADA RANGE RESERVE

By C. L. Forsling

Grazing Examiner, U. S. Forest Service.

The operations in the collection of the soapweed plants, the preparation of the material ready for feeding, and the actual feeding to stock under range conditions involve:

1. Burning away the dead leaves from the soapweed stems.
2. Selection and cutting of the plants in the field.
3. Hauling from the field to the chopping machine.
4. Chopping.
5. Feeding.

Burning Away the Dead Leaves.—The first operation involves the burning away of the dry dead leaves. Their low nutritive value and high fiber content make this portion of the plant undesirable for use

as feed. The presence of the dead leaves also makes chopping more difficult since there is a tendency to clog the machine, so that removal seems advisable. This can best be accomplished by burning the dry portion on the plants as they stand in the field, providing there is not enough vegetation on the ground so that fire will spread. One man with a torch working ahead of the cutting and hauling crew can burn the dry portion from eight to fifteen tons of the soapweed plants per day. A simple and effective torch for burning may be made from a dead soapweed trunk 12 to 18 inches long, carried on an iron rod five or six feet long with a small hook at one end. Dry, dead trunks are plentiful, light and easily handled.

The dry leaves burn readily, and in a short time, leaving the green foliage at the top of the plants and the succulent stem of the plant uninjured. Burning can be done best on days when there is no wind or only light wind, as high winds often extinguish the fire before the dry portion is completely burned.

Where there is danger of fire spreading over the range, burning should be done after the plants have been hauled to some bare spot, preferably near the chopping machine, by scattering them on the ground and applying the torch. To avoid undue shrinkage in burning the plants should be placed in rows two plants wide, with the butts together and the green tops outside. This precaution prevents fire hot enough to burn the green leaves or succulent stem, and the shrinkage is about 30 per cent of the original weight. Where the plants are scattered thickly, burning results in the loss of about 40 per cent on account of the fire becoming hot enough to burn the green leaves.

Selection of Plants, Cutting and Hauling.—In the cutting during the winter and spring of 1918 on the Jornada Range Reserve, plants 36 inches or less in height were not cut, and occasional plants tall enough for the seed stalks to be out of reach of the cattle were left for shade and seed plants. The plants under 36 inches were left on the range, partly as a protection for the soil against wind erosion, partly because they will furnish considerable grazing until the growing tips, seed stalks and flowers are beyond the reach of the cattle, and in part because small plants cannot be handled in the feeding operations as economically as the larger ones.

The plants were cut at the surface of the ground with an ordinary axe. As the plants were cut they were loaded into a wide rack and ar-

ranged orderly, so as to make the most effective use of space and facilitate unloading.

Where feeding operations are on an extensive scale it will be found practical to keep a crew cutting and hauling continually. A crew of four men with two four-mule teams for hauling, can work to good advantage. One man acting as foreman can direct the operations, select the plants for cutting and burn off the dead leaves, if burning is done in the field. Two men with axes cut the plants and hand them up to a third, who arranges them on the rack and drives the team. A crew of this size can select, burn, cut and haul four loads, approximately eight tons of soapweed, per day, where the haul is not over $2\frac{1}{2}$ miles.

Chopping.—At least two types of machines have been developed to convert the stems and leaves into feed. One is on the principle of the ordinary feed chopper, and cuts or slices the stem; the other machine is on the basis of the ordinary “wood hog,” and shreds or tears the plant into particles small enough to be eaten readily by cattle.

The chopper consists of a heavy drum-like wheel 24 to 30 inches in diameter and 12 to 14 inches wide, with several knives on the circumference, which work against a cutter bar or bar of heavy steel on the frame of the machine. This wheel is mounted on a frame and is covered with a hood to prevent throwing of the cut particles of feed. The soapweed plants, after being lifted to the machine, are carried automatically over the cutter bar and the knives on the heavy wheel, which makes 250 to 300 revolutions per minute, chop the stem into particles resembling somewhat thin slices of pineapple.

Three men are required to operate this machine when run at full capacity. One man lifts the soapweed plants to the carrier of the machine, another places them in contact with the knives or feeds the machine, and another is necessary to clear the chopped feed away from the back of the machine. An additional man to assist at the various places will expedite the cutting.

The plants are fibrous and tough, so that the cutting wheel must be maintained at a high rate of speed. A 15 to 20 horsepower engine is required to operate successfully the larger machines first put on the market. These machines, when in proper order and when operated by experienced men, will chop 25 to 30 tons of soapweed per day.

The shredding machine consists of a heavy sheet iron box, approximately 16 inches wide, 16 inches long and 36 inches deep, with a small

drum set with numerous teeth-like knives at the bottom. The soapweed plant is placed on end in the box-like arrangement, and with a slight pressure from the hand of the feeder is forced to come in contact with the drum set full of teeth. This drum is rotated at the rate of 500 revolutions per minute, and the teeth, coming in contact with the soapweed plants, tear or shred them into small particles. This machine may be operated by two or three men, and requires an 8 horsepower engine to run it satisfactorily. The capacity is much lower than that of the larger machine.

Neither machine cuts the leaves of the soapweed extensively, but they are torn apart sufficiently for the cattle to eat them.

Mixing the Soapweed and Cottonseed Meal. The desired amount of cottonseed meal can best be mixed with the chopped soapweed by sprinkling the meal over the chopped soapweed as it is loaded into the wagon beds for hauling to the feed lot. This may be done by loading a layer of soapweed and then sprinkling the meal on top, continuing in successive layers until the load is complete.

Feeding.—The best results have been obtained from feeding the soapweed in troughs. It is possible to feed on hard ground, but at best this is wasteful. When cottonseed meal is fed the troughs are most efficient.

Troughs.—A substantial trough of the following dimensions was found very satisfactory in the feeding operations at the Jornada Range Reserve: Length 15 feet, width 4 feet, depth 12 inches. The troughs were made of 2 inch yellow pine lumber, with bottom “tongued and grooved” to retain the cottonseed meal. The bottom of the trough should be about 18 inches from the ground, with substantial legs at ends and middle, bolted to the sides and securely braced. This makes a trough of large capacity, that will minimize waste, and is high enough from the ground to eliminate most of the danger of weak cows being hooked into the stronger cows. One trough should be provided for 12 to 16 head of cattle, to give the best results in feeding.

Hauling the Chopped Feed.—A common wagon bed 14 to 24 inches deep can be used for hauling the feed from the chopper to the feed lot. An ordinary wagon bed 20 inches deep will hold 1400 to 1800 pounds of the feed, or approximately 20 pounds to the cubic foot, when lightly trampled into the wagon bed.

The chopped feed can easily be handled with an ordinary hay or manure fork. Two men can haul 10 loads per day with a team and wagon, or would be able to feed 1000 cattle per day at the rate of 15 pounds per head per day.

Cost of Soapweed Feeding.—The cost of the different operations in feeding the soapweed, not including cost of cottonseed meal, on the Jornada Range Reserve, was approximately as follows:

Burning, cutting and hauling a distance not exceeding 2½ miles from range to chopper:

1 Foreman and Burner at \$1.66 per day-----	\$ 1.66
3 Laborers at \$1.50 per day-----	4.50
8 Mules (feed) at 50c per day-----	4.00
	\$10.16

Capacity per day, 8 tons.

Cost per ton-----\$1.27

Chopping into feed:

1 Foreman at \$2.00 per day-----	\$ 2.00
3 Laborers at \$1.50 per day-----	4.50
Fuel (Gas and Oil) at \$4.50 per day-----	4.50
Repairs, etc., at \$4.00 per day-----	4.00
	\$15.00

Capacity per day, 25 tons.

Cost per ton-----\$0.60

Hauling from cutter to feed lot:

2 Laborers at \$1.50 per day-----	\$ 3.00
2 Mules at 50c per day-----	1.00
	\$ 4.00

Capacity per day, 10 tons.

Cost per ton-----	\$0.40
Total cost per ton in feed troughs-----	\$2.27

This figure represents the cost after the men become familiar with the work. At first the cost was about \$2.75 per ton. The item of wages includes board. The cost, of course, will vary under different conditions of cost of labor and supplies and distance for hauling the plants and the feed.

SUMMARY

Judging from the results of this single experiment, it is evident that cows may be maintained on either *Yucca elata* or Sotol heads without other feed, through long periods of drouth. No doubt if these cows had been put on feed while they were still in good condition, instead of being very weak and thin, they would have remained in practically as good condition as when put on the feed. But thin cows that need improvement, like those in the experiment, should be given, at least for a time, a small allowance of the cottonseed meal in connection with the *Yucca*.

Not a single cow or calf was lost during the experiment, and all of them went back onto the range the middle of July in as good or better condition than when they were put on the experiment. The ten calves that came during the experiment were all of good size, and normally strong and healthy. They made very good growth, equal to that of the average calf on the range during normal years. The other five, which came in from the range with the cows, were a very thin, half-starved looking lot when they arrived; but the effect of the regular feeding on their mothers' milk supply, in connection with the allowance of cottonseed meal and *Yucca*, which they soon learned to eat, started them to growing. They gained 985 pounds from the beginning of the experiment, January 12, to June 25, at a very small cost of feed, and were in fine condition when they went back to the range the middle of July.

The succulence of the *Yucca* and Sotol plants had a loosening effect in the beginning of the experiment, until the cows became accustomed to it, about the same as any silage would have if given as the only feed to stock taken off of dry feed. But this did not prove at all serious, and nothing was done to check it except giving the cows the run of the brush pasture, where the dry feed that they obtained tended to counteract it. The new growth in the spring, after the sap began to move, had no bad effect in this direction. Although we obtained our supply of *Yucca* every few days, fresh from the mesa throughout the blooming season, there was no perceptible effect from its use. Not a cow was sick or off her feed during the entire experiment, and none were constipated or showed any signs of the clogging of the digestive tract.

Mr. Turney fed two range steers on *Yucca* and cottonseed meal for a number of months, and when they were finally slaughtered for beef

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†Superintendent of the Tucumcari, N. M., Field Station, operated by the
U. S. Department of Agriculture, in co-operation with the New Mexico Agri-
cultural Experiment Station.

the College veterinarian made a careful examination of the digestive tract, and found it perfectly healthy and normal in every respect.

With knowledge now available concerning the feeding value of Yucca and Sotol, and the methods of preparing and feeding them, even prolonged drouth conditions need not cause more than a small per cent of loss on the ranges where either of these plants is available.

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The authors are under obligations to a number of men and companies for the assistance and advice given in connection with this experiment; and they hereby express their full appreciation of all they did to help make the work successful.

Mr. C. T. Turney, of the Jornada Range, furnished the cows, and was instrumental in having one of the first machines made for cutting Yucca placed at the disposal of the institution. He also gave advice on a number of points necessary to make the experiment comply most nearly with range conditions and give results applicable as nearly as possible to the range.

To Mr. C. L. Forsling, Superintendent of the Jornada Range Reserve, who kept exact and complete records of the Yucca feeding carried on by Mr. Turney on the Reserve, they are indebted for the very important practical report on the methods of handling and feeding and the cost of the same, which is made a part of this bulletin.

To Krakauer and Company of El Paso, Texas, they are under obligations for the use of two machines, one of each type, and especially for getting a machine to them in the early part of the experiment, when they were finding it very difficult to get the feed satisfactorily prepared.

They are also indebted to Messrs. Peterson and Sons of Deming, N. M., for contributing a machine of the cutting and shredding type, a machine largely used in the southwestern part of the State.

The demonstration made by Mr. Davies, showing the working of his machine, also manufactured in Deming, by the Davies Manufacturing Company, was very much appreciated.

The negative for the cut used on the cover page, and also those used for cut IV, and VIII, showing the large type of Yucca cutters and range views, were furnished by Mr. C. L. Forsling of the Forest Service, who took the views on the Jornada Range Reserve.