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FEEDING CATTLE AND SHEEP
ON THE RANGE AND IN
THE FEED LOT

H. R. GUILBERT AND R. F. MILLER

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FEEDING CATTLE AND SHEEP ON THE RANGE AND IN THE FEED LOT

H. R. GUILBERT¹ AND R. F. MILLER²

Recent years have brought a great increase in the use of supplemental feeds for the maintenance of breeding stock and for finishing cattle and sheep. Livestock producers are confronted with the problem of selecting from the wide variety of feeds available in California, those that are most economical at varying prices—not necessarily the feed which costs the least per ton, but that which furnishes the essential nutrients at the cheapest rate.

Ordinary feed analyses give the crude protein, nitrogen-free extract, fat, fiber, and ash content of feeds, but do not show the amounts of these constituents that are digestible and therefore available to the animal. The proteins of feeds are extremely important because they are used for growth and maintenance of muscle and other lean tissues, and for milk production. They may also serve as a source of energy. The nitrogen-free extract includes the starches and sugars, which, together with the fats and digestible portion of the fiber, are used for body heat, muscular work, and for fat production.

The value of feeds may therefore be expressed in terms of digestible crude protein and total digestible nutrients. The former represents the value for supplying building material for growth of lean tissues and for the protein requirement of lactation. The latter represents the combined energy or fattening value of all the various nutrients. Feeds high in fiber being low in digestibility, have low values for total digestible nutrients.

Simple means of comparing values, together with data and suggestions on feeding practice, are presented in this circular.

PURCHASING FEEDS ON THE BASIS OF DIGESTIBLE NUTRIENTS

Tables 1 and 2 list the common California concentrates and roughages, with their average digestible crude protein and average total digestible nutrients. The relative cost of 100 pounds of total digestible nutrients of the several feeds at varying prices per ton is also

¹ Assistant Animal Husbandman in the Experiment Station.

² Associate Professor of Animal Husbandry and Associate Animal Husbandman in the Experiment Station.

TABLE 1
THE NUTRITIVE VALUES OF COMMON CALIFORNIA CONCENTRATES AND THE
COMPARATIVE COSTS OF TOTAL DIGESTIBLE NUTRIENTS

Name of feed	Nutrients in 100 pounds of feed		Cost of 100 pounds of total digestible nutrients at a given cost of one ton of feed										
	Digestible crude protein	Total digestible nutrients	\$10	\$15	\$20	\$25	\$30	\$35	\$40	\$45	\$50	\$55	\$60
	<i>lbs.</i>	<i>lbs.</i>											
Molasses, cane.....	1.0	59.5	\$0.84	\$1.26	\$1.68	\$2.10	\$2.52	\$2.94	\$3.36	\$3.78	\$4.20	\$4.62	\$5.04
Pineapple pulp.....	1.0	59.9	0.84	1.25	1.67	2.09	2.50	2.92	3.34	3.76	4.17	4.59	5.01
Manihot meal.....	1.4	79.2	0.63	0.95	1.26	1.58	1.89	2.21	2.53	2.84	3.16	3.47	3.79
Raisins.....	3.4	68.5	0.73	1.09	1.46	1.82	2.19	2.55	2.92	3.28	3.65	4.01	4.38
Figs, dried.....	4.0	68.6	0.73	1.09	1.46	1.82	2.19	2.55	2.92	3.28	3.64	4.01	4.37
Rice, rough.....	4.7	73.1	0.69	1.03	1.37	1.71	2.05	2.39	2.74	3.08	3.42	3.76	4.10
Beet pulp, molasses (dried).....	5.9	75.3	0.67	1.00	1.33	1.66	1.99	2.32	2.66	2.99	3.32	3.65	3.98
Milo heads, ground.....	6.3	68.7	0.73	1.09	1.46	1.82	2.19	2.55	2.92	3.28	3.65	4.01	4.37
Hominy feed.....	7.0	84.6	0.59	0.89	1.18	1.48	1.77	2.07	2.36	2.66	2.96	3.25	3.55
Corn, Indian.....	7.4	84.2	0.60	0.89	1.19	1.48	1.78	2.08	2.38	2.67	2.97	3.27	3.56
Sorghum grain.....	7.5	79.0	0.64	0.95	1.27	1.58	1.90	2.22	2.53	2.85	3.16	3.48	3.80
Rice bran, high grade.....	7.9	65.8	0.76	1.14	1.52	1.90	2.28	2.66	3.04	3.42	3.80	4.18	4.56
Corn, Egyptian.....	8.0	79.0	0.64	0.95	1.27	1.58	1.90	2.22	2.53	2.85	3.16	3.48	3.80
Rice polish.....	8.0	82.1	0.61	0.91	1.22	1.52	1.83	2.13	2.44	2.74	3.05	3.35	3.65
Barley.....	9.0	79.4	0.63	0.94	1.26	1.57	1.89	2.20	2.52	2.83	3.15	3.46	3.78
Wheat.....	9.2	80.1	0.63	0.94	1.25	1.56	1.87	2.18	2.50	2.81	3.12	3.43	3.75
Mill screenings, bolted.....	9.6	65.0	0.77	1.15	1.54	1.92	2.31	2.69	3.08	3.46	3.85	4.23	4.62
Oats.....	9.7	70.4	0.71	1.07	1.42	1.78	2.13	2.49	2.84	3.20	3.55	3.91	4.26
Milo.....	10.7	81.9	0.61	0.92	1.22	1.53	1.83	2.14	2.44	2.75	3.05	3.36	3.66
Wheat bran.....	12.5	60.9	0.82	1.23	1.64	2.05	2.46	2.87	3.28	3.69	4.11	4.52	4.93
Millrun.....	12.9	67.0	0.75	1.12	1.49	1.87	2.24	2.61	2.99	3.36	3.73	4.10	4.48
Cottonseed, whole.....	13.3	80.0	0.63	0.94	1.25	1.56	1.88	2.19	2.50	2.81	3.13	3.44	3.75
Wheat middlings.....	13.4	69.3	0.72	1.08	1.44	1.80	2.16	2.53	2.89	3.25	3.61	3.97	4.33
Coconut meal.....	16.4	80.6	0.62	0.93	1.24	1.55	1.86	2.17	2.48	2.79	3.10	3.41	3.72
Bean screenings (re-cleaned).....	18.0	73.0	0.69	1.03	1.37	1.71	2.05	2.39	2.73	3.07	3.41	3.75	4.09
Cottonseed cake, cold pressed.....	21.1	70.9	0.71	1.06	1.41	1.76	2.12	2.47	2.82	3.17	3.53	3.88	4.23
Linseed meal, old process.....	30.2	77.9	0.64	0.96	1.28	1.60	1.93	2.25	2.57	2.89	3.21	3.53	3.85
Cottonseed cake (40% protein) ..	33.4	75.5	0.66	0.99	1.32	1.65	1.98	2.31	2.64	2.97	3.30	3.63	3.96
Sesame meal.....	36.2	78.2	0.64	0.96	1.28	1.60	1.92	2.24	2.56	2.88	3.20	3.52	3.84
Cottonseed cake (43% protein) ..	37.6	80.6	0.62	0.93	1.24	1.55	1.86	2.17	2.48	2.79	3.10	3.41	3.72
Soybean meal.....	39.7	84.5	0.59	0.89	1.18	1.48	1.78	2.07	2.37	2.66	2.96	3.25	3.55
Peanut meal.....	40.3	83.5	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.69	2.99	3.29	3.59
Fish meal*.....	60.3	69.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* The cost of digestible protein in fish meal at varying prices per ton is given in table 3.

TABLE 2

THE NUTRITIVE VALUES OF COMMON CALIFORNIA ROUGHAGES AND THE
COMPARATIVE COSTS OF TOTAL DIGESTIBLE NUTRIENTS

Name of feed	Nutrients in 100 pounds of feed		Cost of 100 pounds of total digestible nutrients at a given cost of one ton of feed							
	Digest- ible crude protein	Total digest- ible nu- trients	\$5	\$10	\$15	\$20	\$25	\$30	\$35	\$40
<i>Dried roughages</i>										
Alfalfa hay.....	10.6	51.6	\$0.48	\$0.97	\$1.45	\$1.94	\$2.42	\$2.91	\$3.39	\$3.88
Grain hay (oat and barley).....	4.5	50.6	0.49	0.99	1.48	1.98	2.47	2.96	3.46	3.95
Wild oat hay.....	3.8	49.8	0.50	1.00	1.51	2.01	2.51	3.01	3.51	4.02
Sudan grass.....	3.7	51.4	0.49	0.97	1.46	1.95	2.43	2.92	3.40	3.89
Rye grass.....	4.4	47.0	0.53	1.06	1.60	2.13	2.66	3.19	3.72	4.26
Vetch.....	11.6	58.0	0.43	0.86	1.29	1.72	2.16	2.59	3.02	3.45
Vetch and oats.....	6.9	47.1	0.53	1.06	1.59	2.12	2.65	3.18	3.72	4.25
Bean straw.....	3.6	47.6	0.53	1.05	1.58	2.10	2.63	3.15	3.68	4.20
Beet tops (50% moisture).....	7.5	39.5	0.63	1.26	1.89	2.52	3.15	3.78	4.41	5.04
Cottonseed hulls.....	0.3	37.0	0.68	1.36	2.04	2.72	3.40	4.08	4.76	5.44
Barley straw.....	0.9	42.5	0.59	1.18	1.77	2.36	2.95	3.54	4.13	4.72
Kafir stover, dry.....	1.7	47.7	0.52	1.04	1.56	2.08	2.60	3.12	3.64	4.16
Wild oat and bur clover hay.....	6.5	51.9	0.48	0.96	1.44	1.92	2.40	2.88	3.36	3.84
<i>Silage</i>										
Indian corn.....	1.1	17.7	1.45	2.91	4.36	5.81	7.27	.....	.....	.....
Sweet sorghum.....	0.6	13.3	1.88	3.76	5.64	7.52	9.40	.....	.....	.....
Sunflower.....	1.0	12.6	1.98	3.97	5.95	7.94	9.92	.....	.....	.....
Barley.....	2.0	15.8	1.58	3.16	4.75	6.33	7.91	.....	.....	.....
<i>Fresh green roughage</i>										
Alfalfa.....	3.3	14.6	1.71	3.42	5.14	6.85	8.56	.....	.....	.....
Barley.....	2.3	14.7	1.70	3.40	5.10	6.80	8.50	.....	.....	.....
Oats.....	2.3	15.9	1.57	3.14	4.72	6.29	7.86	.....	.....	.....
Wild oats.....	1.5	21.8	1.15	2.29	3.44	4.59	5.73	.....	.....	.....
Sudan grass.....	0.8	13.5	1.85	3.70	5.56	7.41	9.25	.....	.....	.....
Rye grass.....	1.7	15.8	1.58	3.16	4.75	6.33	7.95	.....	.....	.....
Vetch.....	2.7	12.3	2.03	4.07	6.10	8.13	10.16	.....	.....	.....
Vetch and oats.....	2.8	17.0	1.47	2.94	4.41	5.88	7.35	.....	.....	.....
Indian corn.....	1.0	14.7	1.81	3.62	5.43	7.25	9.06	.....	.....	.....
Sweet sorghum.....	0.7	17.1	1.54	3.09	4.63	6.17	7.72	.....	.....	.....
Pumpkins.....	1.1	6.7	3.73	7.46	11.19	14.93	18.66	.....	.....	.....
Fresh figs.....	.....	19.1	1.31	2.62	3.93	5.24	6.54	.....	.....	.....
<i>Roots</i>										
Beets, common.....	0.9	10.2	2.45	4.90	7.35	9.80	12.25	.....	.....	.....
Beets, sugar.....	1.2	14.0	1.79	3.57	5.36	7.14	8.93	.....	.....	.....
Mangels.....	0.8	7.4	3.38	6.76	10.14	13.51	16.89	.....	.....	.....
Carrots.....	1.0	10.6	2.36	4.72	7.08	9.43	11.79	.....	.....	.....

given. That barley at \$20.00 per ton furnishes total digestible nutrients at a cost of \$1.26 per 100 pounds is shown by referring to table 1, opposite barley and in the column headed \$20.00. Similarly, the cost of digestible nutrients in dried molasses beet pulp at \$15 per ton is \$1.00 per 100 pounds, and in wheat bran at \$20.00 per ton is \$1.64 per 100 pounds. Thus, the cost of digestible nutrients at varying feed prices may be readily ascertained. After finding the cheapest sources of total digestible nutrients, one must select combinations that will furnish an adequate ration. For example, dried molasses beet pulp and the grains, being low in protein, must be fed in combination with legume hays or protein concentrates in order to be efficiently utilized. Beet pulp is also deficient in phosphorus and should be fed with phosphorus-rich feeds.

Methods of management frequently impose serious difficulties in selecting the cheapest ration at current feed prices. Thus, in the feeding of stock cattle and sheep on the range, it is often most convenient to utilize cottonseed cake or shelled corn, which may be fed on the ground. The expense of providing troughs is thereby avoided and the animals may be fed where they are grazing—an advantageous procedure from the standpoint of the stock and utilization of the range. Only a few of the feeds available, however, may be fed in this way without excessive waste. This restriction is frequently an important limiting factor in economical buying. Stockmen, accordingly, should balance the cost of providing the equipment necessary to permit the utilization of any feeds which will serve their purpose against the increased cost which may result from being limited to one or two feeds.

Though the replacement value of the feeds listed in table 1 is accurately expressed on the basis of their total digestible nutrients when fed in balanced rations, a few feeds, having special characteristics, require brief discussion.

Yellow corn is a good source of vitamin A, a food essential in which the other concentrates listed are deficient, as are also dry, bleached range feed and hays that have lost their green color.

The so-called cottonseed poisoning that occurs when animals are fed solely on hulls and meal is caused by vitamin A deficiency and may be prevented by the addition of alfalfa hay to the ration.

Raisins, figs, and bean screenings, having a laxative effect when consumed in too large amounts, are usually fed with other concentrates. Rice polish, rice bran, and wheat likewise give better results in combination with other feeds.

PROTEIN CONCENTRATES

The feeds listed in table 1, containing from 16 to 60 per cent digestible protein are referred to as protein concentrates. In general, the protein concentrates listed will give approximately equal results when fed in amounts that will supply equal quantities of digestible protein. Fish meal has not been extensively used in the United States as a protein supplement except for swine and poultry. It may, however, be fed to cattle and sheep. Considerable quantities are used for this purpose in European countries and in British Columbia, and it has given good results in trials with fattening lambs at the California Experiment Station. Since it is extremely rich in protein of high quality, only small amounts are required.

In the following sections, rules and suggestions are given regarding the amount of "protein concentrate" to be used under various conditions. The amounts recommended are based upon the more commonly used feeds, such as 40 to 43 per cent protein cottonseed meal or cake. If concentrates of lower or higher protein values are employed, the amount fed should be adjusted accordingly.

As the cost of digestible nutrients in protein concentrates is normally higher than in grains or in other carbohydrate-rich feeds, the minimum amount that will balance the ration should generally be employed, and the selection should be based upon the cost of digestible crude protein supplied. Table 3 gives the nutritive values of concentrates rich in protein and the comparative costs of digestible crude protein.

MINERAL CONTENT OF FEEDS

The mineral constituents of feeds are essential for skeletal development and for the vital processes of the body. Salt is generally fed to all livestock because feeds do not ordinarily contain a sufficient amount to meet their requirements. Calcium and phosphorus, being the principal minerals in the bones and in milk, are required in relatively large amounts and, with the exception of salt, are most apt to be deficient. Iodine deficiency, resulting in general unthrifty condition and goitrous offspring, occurs in restricted areas and can be easily corrected by the use of iodized salt. Table 4 shows the approximate range in calcium and phosphorus content of some of the principal classes of feeds, arranged in order of increasing phosphorus content.

TABLE 3
NUTRITIVE VALUES OF CONCENTRATES RICH IN PROTEIN AND COMPARATIVE COSTS
OF DIGESTIBLE CRUDE PROTEIN

Name of feed	Nutrients in 100 pounds of feed		Cost of 100 pounds of digestible crude protein at a given cost of one ton of feed									
	Digestible crude protein, pounds	Total digestible nutrients, pounds	\$15	\$20	\$25	\$30	\$35	\$40	\$45	\$50	\$55	\$60
Fish meal*.....	60.3	69.3	\$1.23	\$1.66	\$2.08	\$2.49	\$2.91	\$3.32	\$3.74	\$4.15	\$4.57	\$4.98
Peanut meal.....	40.3	83.5	1.86	2.48	3.10	3.72	4.34	4.96	5.58	6.20	6.82	7.44
Soybean meal.....	39.7	84.5	1.89	2.52	3.15	3.78	4.41	5.04	5.67	6.30	6.93	7.56
Cottonseed cake, (43% protein).....	37.6	80.6	1.99	2.66	3.32	3.99	4.65	5.32	5.98	6.65	7.31	7.98
Sesame meal.....	36.2	78.2	2.07	2.76	3.45	4.14	4.83	5.52	6.21	6.90	7.59	8.28
Cottonseed cake, (40% protein).....	33.4	75.5	2.24	2.99	3.74	4.49	5.24	5.98	6.73	7.49	8.23	8.98
Linseed meal, old process.....	30.2	77.9	2.48	3.31	4.14	4.97	5.79	6.62	7.45	8.28	9.11	9.93
Cottonseed cake, cold pressed.....	21.1	70.9	3.55	4.74	5.92	7.11	8.29	9.48	10.66	11.85	13.03	14.22
Coconut meal.....	16.4	80.6	4.57	6.10	7.62	9.15	10.67	12.20	13.72	15.24	16.77	18.29

* Data from Province of British Columbia, Department of Fisheries. The crude protein content of fish meals varies from about 50 per cent to 68 per cent, and the digestible protein content varies accordingly.

TABLE 4
APPROXIMATE RANGE IN CALCIUM AND PHOSPHORUS CONTENT OF SOME
OF THE PRINCIPAL CLASSES OF FEEDS

Feeds	Calcium, per cent	Phosphorus, per cent
Dry alfalfa.....	1.5—2.5	0.04—0.12
Dry range grasses.....	0.2—0.4	0.05—0.20
Dried molasses beet pulp.....	0.8—0.9	0.06—0.10
Nonlegume hays.....	0.2—0.6	0.15—0.35
Legume hays.....	1.0—2.0	0.15—0.35
Dry bur clover from range.....	1.2—1.5	0.25—0.35
Grains.....	0.04—0.15	0.25—0.40
Bur clover—green (percentage of the dry matter)	1.00—1.50	0.30—0.50
Alfalfa—green (percentage of the dry matter)...	1.50—2.00	0.30—0.60
Range grasses—green (percentage of the dry matter).....	0.30—0.50	0.30—0.60
Wheat bran.....	0.05—0.07	1.20—1.30
Protein concentrates (from plant sources).....	0.25—0.36	0.60—1.50
Fish meal.....	5.00—7.00	2.50—3.50
Bone meal*.....	32.20—.....	14.30—.....
Dicalcium phosphate*.....	27.80—.....	19.70—.....
Monocalcium phosphate*.....	14.10—.....	19.30—.....

* Analyses of commercial products especially prepared and offered for sale for animal feeding.

Cattle and sheep subsisting on dry range vegetation are most liable to be deficient in phosphorus, particularly on grass and alfilaria ranges. Bur clover, on the other hand, supplies sufficient phosphorus. Animals subsisting on dry grass or wild oat hay may also be deficient in calcium. In general, seeds and grains are low in calcium and high in phosphorus, while the roughages, with some exceptions, are relatively high in calcium but sometimes deficient in phosphorus. Though the exact requirements under different conditions are not definitely known, it is desirable to maintain a calcium content of not less than 0.5 per cent and a phosphorus content not less than 0.25 per cent in rations for beef cattle and sheep. In the foregoing discussion, calcium and phosphorus are expressed in percentage on the basis of the elements. Frequently the calcium and phosphorus contents of feeds are expressed as the oxides CaO and P_2O_5 . To convert CaO to calcium, multiply by 0.71; and to convert P_2O_5 to phosphorus, multiply by 0.44.

The three mineral sources of phosphorus which at present appear most practical to use are bone meal, dicalcium phosphate, and monocalcium phosphate. Mineral feeding tests with range livestock conducted by Lantow at the New Mexico Experiment Station have indicated that monocalcium phosphate might be the most efficient mineral to use. As both monocalcium and dicalcium phosphate furnish a higher percentage of phosphorus than bone meal, smaller amounts are required. The fact that monocalcium phosphate also furnishes calcium in lesser amounts is probably advantageous, particularly on alfilaria ranges where calcium is furnished in excess by the forage. The other minerals might be better supplements for grass ranges, where the need for calcium is greater. The calcium and phosphorus content of these minerals appear in table 4.

FEEDING OF STOCK CATTLE

Economy demands that production be placed upon an efficient basis. Percentage calf crop and continuous growth of young stock are extremely important. The production of the same number of calves of better quality from fewer cows, which results from good care and management, offers more chance for profit than do larger numbers maintained under unfavorable conditions. Likewise, young animals that make continuous growth require less time to reach market weight, with a consequent reduction in overhead for maintenance. Supplemental feeding, begun early, in excess of bare maintenance, keeps the cows in good condition, thereby enabling them to produce strong calves, to give ample milk, and to breed early for next year's calf crop. Heifers,

particularly when calving at two years of age, require liberal feeding to minimize losses and to insure their development into rugged cows. Weaning time is a critical period for calves and frequently involves a severe "setback." Though not so essential when older cattle were marketed, the wintering of calves in good condition is extremely important when they are to be marketed at younger ages. Teaching calves to eat concentrates at weaning time not only is advantageous for developing the calves, but also may be valuable later when supplemental feeding is required. Difficulty is frequently encountered in getting older cattle to eat concentrates, particularly on the range. Old cows will sometimes refuse to eat even though they are starving, and valuable time may be lost in getting fattening steers started on feed. Such difficulties are obviated when the cattle have been taught to eat concentrates as calves. In order that feeding may be effective and economical, the different classes of stock should be segregated so far as practicable and each class fed according to its needs. Though the ideal situation is to maintain the entire herd in thrifty condition, there is usually a certain percentage of thin and weak cows when the calves are weaned in the fall. These in particular should be culled out and started on feed early. Feeding weak cows along with the stronger ones is not advisable.

Wintering on Hay.—Information and suggestions, particularly applicable for wintering cattle on hay in northern California counties are itemized as follows:

1. The amount of feed required will depend upon the condition of the cattle, the amount of supplementary grazing, and the severity of the weather.

2. About 15 pounds of alfalfa hay or 20 pounds of meadow hay, grain hay, or other low-protein roughage will ordinarily be required daily per cow.

3. One pound of protein concentrate (see page 7) fed daily with low-protein hays will maintain cattle in more thrifty condition than hay alone and, because of more efficient utilization of the feed, will replace about 5 pounds of hay. After the ration has been balanced, further reduction in roughage (in case of shortage) may be made either by additional protein concentrate or by grains, depending on which furnishes the cheapest source of digestible nutrients. Each pound of additional concentrate will replace approximately 2 pounds of roughage. The roughage should not ordinarily be reduced below 8 pounds a day for mature animals.

4. Grains form a satisfactory concentrate supplement with alfalfa or other legume hays.

5. Three pounds of alfalfa hay are approximately equivalent to 1 pound of 40 per cent protein cottonseed cake for balancing low-protein roughages. The use of legume hay or protein concentrates for this purpose increases the rate and decreases the cost of winter gains in young cattle.

6. Cows that are in strong condition in the fall may be wintered satisfactorily on straw that is supplemented with 3–5 pounds of legume hay or 1–2 pounds of protein concentrate daily.



Fig. 1.—These cattle were losing weight and becoming unthrifty even though the dry feed was abundant. Supplementing the deficiencies of the forage renders possible its efficient utilization.

Supplementing the Range.—Information and suggestions for supplemental feeding of stock cattle on dry range feed, particularly during the fall months, are presented as follows:

1. Bur clover has a high protein content even in the dried feed and, if sufficient in quantity, will maintain stock in good condition late in the season.

2. The low protein and phosphorus content of dry grasses and alfalaria becomes a limiting factor in maintaining live weight even though the forage is abundant. Protein concentrates are therefore best adapted as supplementary feeds. Grains, though distinctly beneficial, are less effective than protein concentrates.

3. One to 3 pounds of supplement per cow daily, depending on the quality of the feed and the condition of the cattle, will usually suffice. One pound a day for calves and $1\frac{1}{2}$ pounds for yearlings should approximately meet requirements. When the cost of digestible nutrients

in protein concentrates is higher than in grains and other feeds, a minimum of 1 pound daily of protein concentrates (see page 7) may be fed, and the additional concentrates required may be selected from the cheapest source of total digestible nutrients.

4. For weaner calves, a small allowance of alfalfa hay in addition to the concentrate supplement is desirable, particularly if they have been running with their mothers on dry feed for several months. A mixture of equal parts alfalfa meal, protein concentrate (such as cottonseed meal), and grain or dried beet pulp would make an excellent ration, convenient to feed. If the calves are to be finished as yearlings or sold as feeders at the end of the green-feed season, liberal feeding in the fall after weaning is desirable.

5. According to present evidence, access during the dry period to a phosphorus-rich mineral or to a mixture of the mineral with salt will materially assist in maintaining cattle that are kept for long periods on dry forage composed largely of grasses and alfalfa. The cost is small because only a small amount is required. Where mineral deficiency exists, mineral supplements not only improve the condition of the cows and the percentage calf crop, but also result in marked increase in the size of the calves. The essential minerals may be obtained at reasonably low cost. Complicated and expensive mixtures are not recommended, not only because of unnecessary expense, but also because such mixtures are frequently made in one part of the country for general distribution, irrespective of local requirements. According to the meager data available, about 4 pounds of bone meal or 2 pounds of dicalcium phosphate or 2 pounds of monocalcium phosphate per month for mature animals would supply adequate amounts of phosphorus, in conjunction with the dry forage. Since animals do not ordinarily take these minerals voluntarily except when in an advanced stage of depletion, the feeding of the mineral on the range presents serious problems. Salt requirement varies on different ranges and during different years on the same range, and is not necessarily correlated with the need for phosphorus. Mixing phosphatic minerals with salt may therefore have limitations in supplying adequate amounts of each. Beneficial results, however, have been obtained by this method. When bone meal is used, the animals may be started on a mixture of 1 part bone meal and 3 parts salt, and after they become accustomed to it the amount of bone meal may be increased. As much as 2 parts of bone meal to 1 part of salt has been used. Because of the odor of bone meal, cattle will frequently refuse to eat it, or a mixture containing it, when it is first offered to them. Mixtures of the other minerals with salt might vary as follows: dicalcium or mono-

calcium phosphate 1 part, salt 2 to 3 parts. If salt consumption is low and the need for phosphorus acute, a larger proportion of the phosphatic mineral might be necessary to approach the monthly consumption indicated above. Since the phosphatic minerals are finely ground they tend to settle out when mixed with coarse salt. Finely ground salt is therefore preferable. (See pages 7 to 9 for mineral content of feeds.)

6. A suggested procedure for supplemental feeding of a breeding herd on dry grass and alfalfa range is as follows: After the forage has matured and dried, provide a mineral mixture in accordance with the



Fig. 2.—Modoc County cattle being wintered in thrifty condition and without death loss on dry swamp vegetation and about 150 pounds per animal of cottonseed cake. Prior to the use of the supplement, this swamp forage had been considered to have no value. (Photo by John C. Hays.)

suggestions in the preceding paragraph. If the cattle will take the mineral alone, as they are most likely to do late in the dry-feed season, allow access to it in a separate trough. Although the mineral supplement will alleviate the phosphorus deficiency of the range forage, it will not supply protein, which is also deficient. A small allowance of cottonseed cake or other protein feed throughout the dry-feed period will therefore help maintain milk flow and increase the gain of the calves. If this procedure is not economically possible, begin feeding protein concentrate in September or October, depending on the condition of the range and the cattle. Feed about $\frac{1}{2}$ pound per head daily at first, and after all cattle are eating it increase the allowance to 1 pound daily. The amount may be increased, or grain may be fed in addition to the protein concentrate if necessary to maintain the cattle in good condition. If green feed has not started or is limited in quantity, 2 to 3 pounds of supplement fed daily to pregnant cows during the period from 30 days before to 30 days after calving is advantageous. Grain supplements may be used

with green feed. Proper supplemental feeding should prevent poverty losses, decrease the frequently high mortality of newborn calves, increase the size of calves at weaning age, and extend the productive life of the females. The conditioning of bulls and the establishment of a definite breeding season are also important. Supplementing early in the fall insures successful rearing of early calves, which, when the cows are well cared for, have a distinct advantage.



Fig. 3.—Fattening yearling steers in dry lot. As the “margin” is frequently small, good business judgment, efficient and economical rations, and careful attention to the details of feeding are essential for profitable dry-lot feeding.

FINISHING CATTLE

Frequently cattle are not in marketable condition at the end of the green-feed season. The decreasing popularity of heavy cattle, the small return for carrying them another year, and the depressing effect on the market of half-fat cattle are factors that have increased the number of cattle finished annually on concentrates. If the cattle do not finish on grass alone the range producer must weigh the relative economy, respectively, of supplementing the range, of finishing the cattle in dry lot with locally available feeds, of consigning them to a commercial feed lot, or of selling them as feeders. The following data and suggestions may assist the producer who is interested in finishing cattle.

Finishing in Dry Lot.—Information and suggestions for fattening cattle in dry lot are presented as follows:

1. Under average conditions cattle will consume dry feed daily at the rate of approximately 3 per cent of their live weight.

2. A full feed of concentrates usually varies from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds per 100 pounds of live weight daily, although calves that are being fed for early finish may consume as much as 2 pounds of concentrates per 100 pounds live weight. The economy of full feeding compared with limited feeding depends on the relative cost of concentrates and roughages, on the class, age, and quality of the cattle, and on market demand for finish. Trials with yearling steers fed alfalfa hay and barley indicated full feeding to be more practical than limited feeding when the cost per ton of concentrates was not more than $2\frac{1}{2}$ times that of the roughage. Calves cannot be properly finished without liberal concentrate feeding.

3. The approximate time and gain required to finish for Pacific Coast markets are as follows:

	<i>Time</i>	<i>Gain</i>
Two-year-old steers.....	2-4 months	150-250 pounds
Yearling steers.....	4-5 months	250-350 pounds
Calves.....	6-7 months	350-450 pounds

4. The rate of gain and the feed required per pound of gain are extremely variable, depending on the quality and condition of the cattle, the quality of feeds, and the proportion of concentrates in the ration. The data in table 5 were obtained with good-quality calves and yearlings, fed alfalfa hay and rolled barley. Similar gains and feed requirements have been found for rations consisting of grain hay, barley, and 2 pounds daily of protein supplement; and likewise for equal parts of grain hay and alfalfa hay fed with barley and 1 pound daily of protein supplement.

TABLE 5
GAINS AND FEED REQUIREMENTS OBTAINED FROM FEEDING TRIALS WITH
CALVES AND YEARLINGS

	Number of trials	Number of days fed	Rate of feeding concentrates, per cent of live weight daily	Pounds feed per pound gain		Daily gains, pounds
				Barley	Alfalfa	
Calves.....	2	210	1.50	4.6	3.3	2.13
Yearlings.....	3	130	1.25 to 1.50	4.1	4.7	2.15
Yearlings.....	1	120	1.00	3.5	6.9	1.91
Yearlings*.....	1	128	0.50	1.8	9.1	1.90

* These steers did not carry sufficient finish to market to best advantage at the end of 128 days.

5. Two-year-old steers will require, on the average, 15 to 25 per cent more feed to produce a pound of gain than yearlings. With good-quality feeds and favorable environmental conditions, young cattle make the most economical gains; but on poor-quality feed or under unfavorable conditions older cattle have an advantage.

6. The optimum gains to be expected with good cattle, which have been full-fed concentrates over an average feeding period, are 2, $2\frac{1}{4}$, and $2\frac{1}{2}$ pounds daily for calves, yearlings, and two-year-old steers, respectively. Heifers under the same conditions will gain slightly less than steers but will finish more quickly. Two-year-old steers will gain from 1 to $1\frac{1}{2}$ pounds daily on alfalfa hay alone over a 90–120 day feeding period. The apparent gains made over short periods are frequently very misleading because of the effect of “shrink and fill.”

7. When alfalfa hay is the sole roughage, a protein supplement is not required, but may be added with some advantage if the cost of total digestible nutrients is about the same as in the grains. In some areas difficulty with bloat is encountered with a ration of alfalfa hay and barley. Under such conditions, the substitution of grain hay for one-half of the alfalfa and the replacing of 1 to $1\frac{1}{2}$ pounds of barley with protein concentrate results in a more satisfactory ration.

8. When grain hay or other low-protein roughage is fed, 2 to $2\frac{1}{2}$ pounds of protein concentrate daily (see page 7) for each 1,000 pounds of live weight are required to balance the ration. Any additional concentrates should be selected on the basis of the cost of total digestible nutrients.

9. A mixture of two or more concentrates, together with variety in the roughage, increases palatability and is desirable, especially in the rations of young cattle. Increasing the allowance of protein concentrate in the ration during the last few weeks of the fattening period stimulates the appetite of the animals and is good feeding practice.

10. Barley should be ground or rolled for cattle feeding. The grain sorghums should also be ground. Wheat should be cracked or coarsely ground, but never finely ground because of its gummy nature; it gives best results when fed with other grains. Dried molasses beet pulp is a very palatable feed and may replace part or all of the grain ration. A ration consisting of either dried or wet beet pulp and alfalfa hay is liable to be deficient in phosphorus. In a feeding trial conducted by Maynard of the Utah Experiment Station, the addition of $\frac{1}{10}$ pound of bone meal, or 2 pounds of cottonseed meal per head daily, to such a ration greatly increased the rate of gain of fattening steers. Raisins, ground rough rice, rice bran, and rice polish may be substituted for part

of the grain ration when the cost of digestible nutrients warrants so doing. Molasses is a valuable appetizer and fattening feed. Under ranch conditions, however, the attraction it has for flies and the labor of handling discourage its use. For feeding it may be diluted and mixed with the roughage; but probably the most convenient and practical method is to spread it in troughs and cover it with the grain mixture.

11. Success in feeding depends as much upon the care exercised in the details of feeding as upon the selection of a satisfactory ration. Feeding concentrates separate from the roughage has some advantage in that the feeder has more ready control of the most expensive part of the ration. Greater care must be exercised, however, in getting the cattle on feed and in preventing greedy animals from getting too much grain, than if the concentrates are mixed with chopped hay or other bulky feeds. When fed separately, the concentrates should be fed first, and the roughage consumption regulated according to the appetites of the animals. Occasionally, with particularly palatable roughage, and especially with young cattle, one must limit the roughage allowance in order to induce sufficient consumption of concentrate for rapid finishing. Especial care is necessary in starting cattle on feed. There should be ample room at the feed troughs, and small amounts of concentrates should be given until all cattle are eating. The grain should be increased gradually until the desired amount is reached. Appetite is the best guide: the animals should always be hungry at feeding time and should never be given more concentrates than they will clean up in one-half to three-quarters of an hour. Regularity in feeding, keeping the troughs clean, and having the cattle as quiet as possible are important factors.

12. The feeding schedules shown in tables 6 and 7 give the approximate amounts of feed consumed daily by cattle of good breeding and quality when full-fed on concentrates. In making these schedules it has been assumed that calves, yearlings, and two-year-old steers so fed would make an average daily gain of about 2, 2¼, and 2½ pounds, respectively. The initial weight assumed for calves is 350 to 400 pounds, for yearlings 600 to 700 pounds, and for two-year-old steers 850 to 900 pounds. The rations are balanced with regard to the kind of roughage fed.

Finishing on Range or Pasture.—Information and suggested procedures for supplemental feeding of fattening cattle on the range are presented as follows:

1. On ranges containing considerable bur clover, a minimum of 1 to 2 pounds of protein concentrate (see page 7) should be fed daily for each 1,000 pounds of live weight. On alfalfa and grass ranges the

minimum amount will be from 2½ to 3 pounds daily for each 1,000 pounds of live weight. Additional concentrates should be purchased on the basis of cost of total digestible nutrients. Variety and palatability in the concentrate ration as discussed under dry-lot feeding is equally important in range feeding.

TABLE 6

SCHEDULE FOR FEEDING GRAINS SUCH AS BARLEY, WHEAT, GRAIN SORGHUMS, CORN, OR COMBINATIONS, WITH ALFALFA OR OTHER LEGUME HAY
(Average daily ration in pounds)

	Calves			Yearlings			Two-year-olds		
	Grain	Protein supplement*	Roughage	Grain	Protein supplement*	Roughage	Grain	Protein supplement*	Roughage
First month.....	4.0	None	8.0	6.0	None	12.0	8.0	None	16.0
Second month.....	6.5	None	7.0	8.5	None	10.0	11.0	None	14.0
Third month.....	9.0	None	7.0	11.5	None	9.0	14.0	None	12.0
Fourth month.....	10.5	0.5	6.0	12.0	1.0	9.0	14.0	1.5	12.0
Fifth month.....	12.0	1.0	5.0	12.5	1.0	9.0	.....	.....	.....
Sixth month.....	12.5	1.0	5.0	.....	.....	.....	.....	.....	.....

* No protein supplement is required with legume hay as the sole roughage. If the cost of the ration is not materially increased thereby, the addition of a small amount during the latter part of the finishing period is advantageous because it tends to stimulate the appetite and to produce more "bloom" in the animals.

TABLE 7

SCHEDULE FOR FEEDING GRAINS SUCH AS BARLEY, WHEAT, GRAIN SORGHUMS, CORN, OR COMBINATIONS, WITH GRAIN HAY OR OTHER NONLEGUME ROUGHAGES*
(Average daily ration in pounds)

	Calves			Yearlings			Two-year-olds		
	Grain	Protein supplement	Roughage	Grain	Protein supplement	Roughage	Grain	Protein supplement	Roughage
First month.....	3.00	1.00	8.0	5.0	1.0	12.0	6.5	1.5	16.0
Second month.....	5.00	1.50	7.0	7.0	1.5	10.0	9.0	2.0	14.0
Third month.....	7.25	1.75	7.0	10.0	1.5	9.0	12.0	2.0	12.0
Fourth month.....	9.00	2.00	6.0	11.0	2.0	9.0	13.0	2.5	12.0
Fifth month.....	11.00	2.00	5.0	11.5	2.0	8.0	.....	.....	.....
Sixth month.....	11.50	2.00	5.0	.....	.....	.....	.....	.....	.....

* Grain hay and other nonlegume roughages are frequently low in calcium. The addition of 1/10 pound daily of calcium carbonate or pulverized oyster shell is recommended in the ration for calves.

2. Twenty-four head of short two-year-old steers were fed in 1931 on dry alfilaria range which had been severely damaged by rain. The average initial weight was 650 pounds. One pound of supplement was fed daily at the beginning and increased to 11 pounds during the last six weeks. The average daily supplement fed during the entire period (May 9 to September 30) was 5.0 pounds, and the average daily gain was 1.24 pounds. Thus, 4 pounds of supplement was required for 1 pound of gain. The daily gain during the last six weeks when the cattle received the heavier grain ration was 1.9 pounds.



Fig. 4.—Finishing two-year-old steers on the range. These cattle were “drifted” in from the range each morning and allowed to take their fill of water. They were then given the concentrate ration in the feeding corrals.

3. The dry matter of green-range feed, particularly in the early stages, is high in protein and minerals. Grains, accordingly, are more suitable than protein concentrates for supplementing the green feed. Cattle will frequently discontinue eating cottonseed cake when green feed becomes plentiful. Although few data are available, it is probable that palatable grain mixtures can be fed throughout the green-feed season.

4. Cattle that are maintained in thrifty condition in the fall by supplemental feeding are able to attain greater finish on grass, with a consequent reduction in the concentrate requirement during the finishing period.

5. Suggested procedure for finishing two-year-old steers: while the yearlings are on the dry forage in the fall, feed them 1 to 2 pounds of protein concentrate until green feed is available. If green feed does not start until late, with prospect of delayed growth because of cold weather, the protein concentrate may be replaced by grains and continued until the new feed is sufficient in quantity and quality to produce good gains. From the time green range feed is sufficient in quantity and quality to

produce good gains until the forage matures, give no supplemental feed. At the beginning of the dry-feed season, start the cattle on a limited concentrate ration and gradually increase the amount as necessary to finish them before the fall rains commence. An alternative plan would be to feed the cattle the same as outlined above during the fall, but to full feed them from the beginning of the dry-feed period until they are finished. The total concentrates required for a short period of heavy feeding may not exceed that of a long period of limited feeding and frequently results in better finish. After adjusting the protein concentrate allowance according to the suggestions for range feeding, the schedules in table 7 could be used as a guide for full feeding of concentrates.

6. No definite data are available on finishing calves and yearlings on the range. Procedures which have practical possibilities but which have *not been tested under California conditions* are herewith outlined.

(a) From weaning time until green feed is plentiful, feed a mixture balanced with respect to the composition of the range feed and selected from cheapest sources of total digestible nutrients, at the rate of about 1 pound per 100 pounds live weight. (Example of desirable ration: equal parts of ground barley, dried molasses beet pulp, molasses-alfalfa meal, and cottonseed meal.) During the green-feed season, give no supplemental feed. In the dry-feed season, full-feed a concentrate mixture until the cattle are finished—probably 100 to 150 days. (Example of desirable ration: 1 part pea-size cottonseed cake, 2 parts ground barley and 2 parts ground wheat, milo or beet pulp.)

(b) Feed weaner calves the same as outlined above during the fall, but full-feed concentrates during the green-feed season with the view of finishing for market in June. Heifers fattened in this manner would sell to better advantage than when older and would finish in less time than steers of comparable age and quality. (Example of desirable ration: equal parts of ground or rolled barley, ground wheat or milo, and dried molasses beet pulp.)

(c) Feed yearling cattle a small allowance of concentrate supplement during the fall and early winter, as outlined under section 5, and full-feed during the green-feed period. Good type, well-bred, quality cattle are necessary in order to finish as calves and yearlings.

FEEDING BREEDING SHEEP

A high percentage lamb crop of good quality is essential to economical production. By rigid culling and improved feed conditions it is possible to raise more and better lambs from fewer ewes. There are two



Fig. 5.—Breeding ewes being maintained in thrifty condition during the fall by supplementing the dry range forage with concentrates.

periods when proper nutrition of range ewes is of vital importance: namely, during the breeding period and during the wintering period.

The Breeding Period.—Generally, throughout the Sacramento and San Joaquin Valley districts in California, the ewes are bred during the months of July and August while they are grazing on barley stubble with practically no green feed available. Sheepmen report each year a large percentage of dry ewes, and there is some evidence that the cause is the lack of at least some green feed during the breeding period. The condition and the thriftiness of the ewe at mating time are closely asso-



Fig. 6.—A practical and cheaply constructed type of trough and corral arrangement for supplemental feeding. The concentrates are distributed in the troughs before the ewes are turned into the feeding pen.

ciated with fertility, and to obtain a large percentage lamb crop the nutrition of the ewes should receive more attention. With this end in view, the following suggestions are made regarding the feed for ewes at breeding time under prevailing conditions:

1. Reserve a choice field of barley stubble having a considerable growth of morning-glory and perhaps wild lettuce or other plants to provide some green feed.

2. An ideal arrangement would be to have a barley stubble field adjacent to an old alfalfa field, herding the ewes on the alfalfa in conjunction with the stubble.

3. An old grain or rice field which has been allowed to go fallow, and which usually is grown up with green plants of different kinds and has a supply of bur clover seeds on the ground, would provide ideal feed.

4. Where green feed is not available, some alfalfa hay might well be fed while the ewes are grazing on the barley stubble. This would provide a balanced ration and the dietary essentials associated with green feed.

5. In case the ewes are bred while grazing on dry foothill grass range, some supplementary feed would be highly desirable. One-quarter pound of cotton-seed cake or one pound alfalfa meal or hay per ewe daily would serve to condition the ewes for reproduction. If clover burs are abundant, extra feeding is not necessary.

6. Ideal conditions would be supplied by an irrigated Sudan grass pasture sufficient to carry the ewes throughout the breeding period. Such a field will carry about 20 ewes to the acre. At the College of Agriculture, a flock of 200 ewes handled in this way and maintained in thrifty condition throughout the year, has produced lamb crops varying from 135 to 160 per cent over a period of 5 years. Sudan grass may also be grown in some sections without irrigation, although the yield is limited. Ladino clover has proved to be an excellent pasture crop where irrigation water can be applied about every two weeks. There is some danger from bloat since it is one of the legumes. In the coast counties Harding grass or rye grasses have been used quite successfully for grazing purposes.

A few precautions might here be added: namely, sheepmen should anticipate their needs and engage ample feed for the entire breeding season, as it is very poor practice to change ewes from one type of feed to another or to compel them to subsist on scant feed during the latter part of the breeding period. The ewes had best be started on the feed reserved for the breeding period 10 days before the rams are turned

with the band. Fresh water, shade, and salt are important factors in the health and thrift of ewes.

As the condition of the rams at breeding time is important, sheepmen usually feed them a ration of barley and alfalfa hay for a period of 3 or 4 weeks beforehand. Furthermore, in order to maintain the rams in vigorous, active condition throughout the mating period, it has been found advantageous to place one-half of them with a band of ewes for two weeks; then to take these out and replace them with the other half



Fig. 7.—Wintering range sheep on alfalfa hay—a forage rich in protein and minerals and an excellent feed for breeding ewes. (Photo by Belden.)

for a similar period; and finally, during the last two weeks, to return the first group of rams and allow all to remain with the ewes until the close of the breeding season. During the rest period, rams are given extra feed to keep them in good condition.

The Wintering Period.—The general practice of lambing in December and January, when range feed is very short, necessitates supplementary feeding during the winter months. Ewes in an advanced stage of pregnancy need a protein-rich diet to provide for the growth of the fetus and also to stimulate the milk flow. The feeds most commonly used are alfalfa hay, cottonseed cake, shelled corn, barley, bean screenings, and beet pulp. A study of table 1, together with the market quotations, will assist the sheepmen in selecting the most economical feeds. The following rations are suggested on the basis of daily feed per ewe, although the amount required will depend largely on the range forage available and the condition of the sheep:

- (1) $\frac{1}{4}$ pound cottonseed or sesame cake with dry range forage.

(2) $\frac{1}{2}$ pound cottonseed cake (cold pressed), where native feed is very short.

(3) 2 pounds alfalfa hay, $\frac{1}{4}$ to $\frac{1}{2}$ pound shelled corn or whole barley.

(4) 2 pounds alfalfa hay, $\frac{1}{4}$ to $\frac{1}{2}$ pound dried molasses beet pulp.

(5) 2 pounds grain hay (volunteer), $\frac{1}{4}$ pound cottonseed or sesame cake.

(6) 2 pounds grain hay (volunteer), $\frac{1}{2}$ pound bean screenings.

Shelled corn and cottonseed cake (sheep size) are the two principal concentrates given to range sheep in California because they may be easily fed by spreading out on the hard ground. The two differ greatly, however, in composition; and experience has shown that ewes fed on corn tend to fatten but the milk flow is not stimulated as lambing time approaches. On the other hand not only do ewes fed on cottonseed cake take on flesh, but the milk flow is stimulated and the udder is full and plump at lambing time, a condition which is very desirable. In composition, barley is similar to corn, although it is somewhat lower in energy value and lacks the fat-soluble vitamin A which may be the reason yellow corn has produced good results. Some sheepmen hesitate to use barley because they believe it will decrease the milk flow of the ewes. The idea is erroneous, unless the barley is fed in large amounts and where natural range feed is very short. Under such conditions, alfalfa hay or cold-pressed cottonseed cake should be supplied. There are two types of cottonseed cake—the hot-pressed and the cold-pressed. The former, being higher in protein, is generally preferred, although the latter is better adapted where the range feed is very short and the sheep require a feed of considerable bulk. Dried molasses beet pulp has been used with good results, particularly where some green feed is available. It may be substituted for barley or corn when the cost of total digestible nutrients is comparable.

Growers should study closely the condition of the sheep and begin feeding while native dry feed is still available. To allow the ewes to lose flesh, or to make a sudden change in the feed of ewes heavy in lamb is apt to prove disastrous. Allow about 1 pound of hay daily per ewe and gradually increase the amount to 2 pounds. Similarly, begin with $\frac{1}{8}$ pound of concentrate and increase the amount to $\frac{1}{4}$ or $\frac{1}{2}$ pound.

Sheepmen have suffered heavy losses in recent years from an ailment commonly known as "lambing paralysis." This condition often occurs when range sheep heavy with lamb are brought in after the dry feed is exhausted and fed liberal amounts of alfalfa hay or other protein-rich feeds. Special care should be exercised in the feeding of ewes that are far advanced in pregnancy. Arrange the supplemental feeding so as to

compel the ewes to take the usual daily exercise. Make any change of feeds very gradually and limit the amount fed until after the ewes have lambed.

Wintering on the Desert.—In some parts of California sheep are wintered on the desert. McCreary of the Wyoming Experiment Station has shown that many of the desert plants, such as salt bush, shad scale, and the various sagebrushes have a crude protein content ranging from 8 to 20 per cent, which is relatively higher than that of the dry grasses and weeds. Cottonseed cake and shelled corn are the concentrates most commonly used, because they may be fed on the ground without waste. The average allowance is $\frac{1}{4}$ pound per ewe daily, although sometimes as much as $\frac{1}{2}$ pound is fed. The relative cost of total digestible nutrients, the protein requirement, and the convenience of feeding are the determining factors in selecting a supplement.

Minerals for Sheep.—When sheep are subsisting on dry forage, particularly grass, alfalfa, and weeds, a deficiency of phosphorus is liable to result. In order to meet this need, bone meal or some other mineral high in phosphorus may be added to the salt. The sheep may be started on a mixture of $\frac{3}{4}$ salt and $\frac{1}{4}$ bone meal, and the bone meal increased to $\frac{1}{3}$ or $\frac{1}{2}$ as the dry season advances. When using dicalcium or monocalcium phosphate, add 1 part to 2 or 3 parts of salt. There has been considerable difficulty in getting sheep to consume bone meal, because of the odor, and for this reason dicalcium or monocalcium phosphate may be better adapted. As definite information on the mineral requirement of sheep is meager, the recommended mixtures may have to be modified according to local conditions. Salt should be kept before the sheep at all times and on an average they require about $\frac{1}{3}$ ounce per head daily. It is usually supplied as half-ground, although some sheepmen prefer a more finely ground salt, fed in troughs or self-feeders.

FINISHING LAMBS

Creep Feeding of Lambs.—In order to finish spring lambs at an early age and to insure a large percentage of fat lambs, many sheepmen have adopted the practice of feeding the lambs grain in specially constructed pens or lamb creeps. The feed is put out in the afternoon ready for the lambs when they come in towards evening. It is important to clean the troughs out every day and feed just what the lambs will consume. A few suggested mixtures are as follows:

(1) 50 pounds rolled barley, 25 pounds rolled oats, 25 pounds wheat bran.

(2) 50 pounds rolled barley, 25 pounds dried molasses beet pulp, 25 pounds wheat bran.

(3) 50 pounds rolled barley, 25 pounds cracked corn, 25 pounds alfalfa meal.

Whole milo grain is sometimes preferred to rolled barley. The mixtures described above may be modified according to prevailing conditions.



Fig. 8.—Creep feeding of range lambs—a practice which results in earlier marketing and a higher percentage of choice and good lambs. Creep panels are set up on both sides of the corral allowing the lambs to come in and out freely but excluding the mothers.

Finishing on Grain Stubble or Beet Tops.—After shipment of fat lambs, a considerable number of feeder lambs usually remain. These are often fattened by turning them into a barley field after the grain has been harvested. During the first month gains on good stubble are fairly satisfactory, but later they are often disappointing, and a considerable percentage of the lambs do not get fat. An alfalfa field in conjunction with the barley stubble is ideal and provides the protein to balance the diet. When the lambs have gleaned the best part of the feed, they should be moved to a fresh field or allowed some supplementary feed.

The following mixtures are recommended at the rate of $\frac{1}{2}$ to 1 pound per lamb daily, depending on the condition of the stubble:

- (1) Rolled barley 75 per cent, cottonseed cake 25 per cent.
- (2) Dried molasses beet pulp 75 per cent, cottonseed cake 25 per cent.
- (3) Rolled barley 50 per cent, cottonseed cake 25 per cent, rice bran 25 per cent.

Substitutions for barley or beet pulp and the oil meals may be made in the above rations, depending on the cost per unit of digestible nutrients, as shown in table 1.

Beet tops are superior to barley stubble for fattening lambs because there is considerable sugar in the crowns that are left on the field. Furthermore, the dried leaves are rather high in protein, which tends to balance the ration. In grazing beet tops, the lambs should be turned into the field soon after the beets are harvested, while the crowns are soft. They should be moved to a fresh field when they have consumed the water portion of the tops, in order to insure a continuous daily gain and a large percentage of fat lambs. Grazing alfalfa in conjunction with beet tops results in very favorable gains. Toward the end of the season, supplementary grain feeding, as outlined for barley stubble, may well be considered.

Finishing Lambs in the Dry Lot.—This is a special branch of the industry, requiring experience and careful study. When prices of feeder lambs are low and home-grown feeds may be secured cheaply, sheepmen should consider the relative advantage of selling feeder lambs or fattening them at home. The important considerations are cost and availability of feeds, condition and type of lambs, and feed-yard equipment.

Lambs of the black-faced type weighing 60 pounds will require 50 to 60 days to fatten, while the merino type of lamb will require 75 to 90 days when fed a ration of grain and hay in the dry lot. An average gain of 9 pounds per month per lamb is fairly satisfactory, and about 350 pounds of grain and 550 pounds of hay will be required to make 100 pounds of gain. The important factor in deriving a profit is the increased price of the fat lamb over the feeder lamb, which is known as the "margin" in feeding operations.

A few daily rations for lambs on full feed, weighing from 60 to 70 pounds, are herewith listed. With the aid of table 1, proper substitutions may be made on the basis of the comparative cost per 100 pounds of digestible nutrients.

(1) Alfalfa hay.....	2 pounds
Rolled or whole barley.....	1¼ pounds
(2) Alfalfa hay.....	2 pounds
Rolled or whole barley.....	1 pound
Cottonseed cake or meal.....	½ pound
(3) Alfalfa hay.....	2 pounds
Rolled or whole barley.....	½ pound
Dried molasses beet pulp.....	¾ pound
(4) Alfalfa meal and molasses (15%).....	2½ pounds
Rolled or whole barley.....	1 pound

An important detail in fattening lambs is to bring the lambs on feed successfully. This matter requires a close study of the lambs and good judgment on the part of the feeder. Lambs that have grazed on barley stubble will take grain more readily than mountain lambs which have grazed exclusively on green vegetation. On arriving at the yards after a prolonged shipment, the lambs should be rested and fed only hay for two or three days. They may then be started on the grain ration, and the schedule shown in table 8 may be used as a guide.

TABLE 8
FEEDING SCHEDULE FOR FATTENING LAMBS

Feeding periods	Pounds of feed per lamb daily	
	Grain	Hay
First 3 days.....	$\frac{1}{8}$	$2\frac{1}{2}$
Next 3 days.....	$\frac{1}{4}$	$2\frac{1}{4}$
Next 3 days.....	$\frac{1}{2}$	2
Next 6 days.....	$\frac{3}{4}$	2
Next 15 days.....	1	2
Next 30 days.....	$1\frac{1}{4}$	$1\frac{3}{4}$

In feeding heavy lambs, weighing 75 to 80 pounds, one may increase the grain allowance to $1\frac{1}{2}$ pounds daily. Mutton-type lambs will consume more grain than the fine-wool type.

Some commercial feed yards have adopted the self-feeding method, using a mixture of alfalfa meal and molasses, ground barley, and cottonseed meal. The proportion of barley is increased and alfalfa meal decreased as the lambs become accustomed to the feed. Volunteer grain hay is often utilized by mixing it with the alfalfa—about 50 per cent of each—before the hay is ground. Experimental evidence indicates that this method results in a greater rate of gain, but usually at a higher cost than hand-feeding at regular intervals. In some cases this method has resulted in rather heavy death losses, probably caused by the lambs' over-eating on this palatable mixture. For that reason, certain operators have adopted the practice of feeding the molasses alfalfa meal and the grain mixture separately. In this way they are able to control the daily grain allowance and greatly reduce the death losses.