Historical Document
Kansas Agricultural Experiment Station

Kansas State Agricultural College.

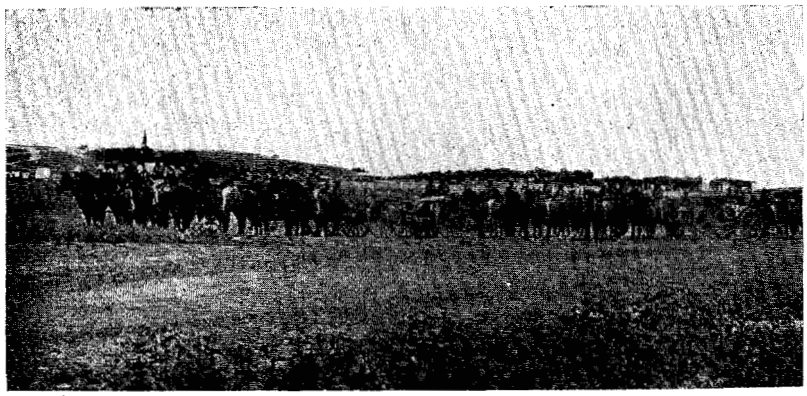
EXPERIMENT STATION.—Bulletin 186.

ED. H. WEBSTER, *Director.*
Resigned Dec. 31, 1912.

FARM BULLETIN.

Animal Husbandry Department.

W. A. COCHEL, *Animal Husbandman in Charge.*



THE ARTILLERY HORSE READY FOR WORK.

Feeding Work Horses.

BY

DR. C. W. MCCAMPBELL, *Assistant Animal Husbandman.*

MANHATTAN, KAN.
DECEMBER, 1912.
4-4661

Historical Document
Kansas Agricultural Experiment Station

ACKNOWLEDGMENTS.

This experiment was proposed and planned by R. J. Kinzer, formerly professor of animal husbandry in the Kansas State Agricultural College.

Grateful acknowledgment is made to the officers and the men detailed for this work at Fort Riley, for the courtesies extended and assistance rendered while this experiment was in progress.

Especial mention is due Col. Eli D. Hoyle, Sixth field artillery, U. S. A.; Dr. A. E. Donovan, veterinarian Sixth field artillery, U. S. A.; Capt. R. B. Powers, quartermaster; and Capt. Raymond Briggs, quartermaster, Fort Riley, for their assistance in bringing this experiment to a successful close.

The work was made possible through the interest and active coöperation of the Secretary of War, the Secretary of Agriculture, the Adjutant General, and the Quartermaster General of the United States Army.

Historical Document
Kansas Agricultural Experiment Station

CONTENTS.

Historical Document
Kansas Agricultural Experiment Station

Feeding Work Horses.

CONCLUSIONS.

1. Oats proved to be a better feed for work horses, especially during the hot summer weather, than corn, when fed with timothy or prairie hay.

2. Corn and oats proved more valuable than corn alone, but not so valuable as oats alone.

3. Corn, when fed with the proper amount of alfalfa hay of the right quality, gave as good results as, and was one-third cheaper, than a ration of oats and prairie hay.

4. Barley has practically the same feeding value as oats, but the cost makes its use prohibitive under Kansas conditions.

5. There is but little difference between bran and alfalfa meal so far as food value is concerned. The physical properties and the cost of alfalfa meal make it an undesirable feed for work horses.

6. One pound of old-process linseed meal equaled, in feeding value, four pounds of bran, when both were fed with corn, oats, and prairie hay.

7. Some feeds may be substituted entirely for oats in a ration, with excellent results, but with practically no reduction in cost.

8. Other feeds may be substituted entirely for oats in a ration, with good results and with some reduction in cost.

9. Certain other feeds may be substituted entirely for oats in a ration, with good results and with a very marked reduction in cost.

10. Timothy proved to be of slightly more value than prairie hay as a roughage.

11. Alfalfa hay, *when properly fed,* is a much more valuable roughage than either timothy or prairie hay, and reduced the cost of daily ration from 25 to 35 per cent when substituted for prairie or timothy hay and fed with corn and oats.

12. Small-grain hays, such as oat hay, wheat hay, barley hay, deserve more attention from the Kansas farmer. They have a higher feed value than either prairie or timothy hay.

13. While every ration discussed may be looked upon as a more or less satisfactory one, so far as the ability of the animals to stand hard work and to maintain their weight and general good health was concerned, some were exceptionally well adapted for horses at hard work, particularly the following rations:

Oats, 4 pounds; corn, 6 pounds; bran, 4 pounds; timothy hay, 12 pounds.

Corn, 6 pounds; bran, 3 pounds; linseed meal, 1 pound; prairie hay, 14 pounds.

Historical Document
Kansas Agricultural Experiment Station

Oats, 2 pounds; corn, 8 pounds; alfalfa hay, 10 pounds.
Oats, 4 pounds; corn, 6 pounds; linseed meal, 1 pound; prairie hay, 12 pounds.
Oats, 12 pounds; prairie hay, 14 pounds.

Each of these rations represents the amounts fed to a horse in one day. The horses averaged about 1150 pounds in weight.

14. Although it is not a cheap one, the ration made up of corn six parts, oats four parts, bran four parts, and timothy hay, is probably the best ration that can be fed a work horse.

15. The combination of corn and alfalfa hay is the cheapest ration that can he fed to a work horse in Kansas, and is one of the best, *when properly fed*.

16. No digestive disturbance could be attributed to any ration used in this experiment.

17. The horses that were fed bran, linseed meal, or alfalfa hay, showed the best condition.

18. Horses that were fed an oats ration did not show any more spirit than those that received corn.

19. Spirit and endurance depend more upon the amount and the quality of the feed than upon the particular kind of feed.

20. The cost of the grain amounts to from 60 to 70 per cent of the total cost of the ration.

21. This experiment shows that a nutritive ratio of about 1: 8 is most satisfactory when the roughage consists principally of timothy or prairie hay.

22. The cost of different rations should not be considered without taking into account the fact that there is wide variation in the cost of feeds from time to time and in the prices quoted in different parts of the state at any given time. For instance, in a certain part of the state feeds were selling at the following prices: oats, 87½ cents a hundredweight; corn, 80 cents a hundredweight; bran, $1.20 a hundredweight; linseed meal, $1.50 a hundredweight. At these prices there was no need for substituting other feeds for oats in order to secure an economical ration. In another part of the state the same feeds were selling at the following prices: oats: $1.60 a hundredweight; bran, 90 cents a hundredweight; linseed meal, $1.75 a hundredweight; corn, $1 a hundredweight. At these prices a corn, bran, and oil-meal combination would make a more economical ration. The substitute value of the various feeds should be given careful consideration. With a knowledge of the feeding value of the feeds available, the most economical ration at prices prevailing in any locality may be computed.

23. The general health and condition of work horses is greatly influenced by the regularity and the manner of feeding.

24. Ability to determine individual peculiarities of the animals plays an important part in successful feeding.

Historical Document
Kansas Agricultural Experiment Station

Feeding Work Horses.

INTRODUCTION.

Throughout the United States and the world in general, there has been far less experimental work conducted with horses than with any other class of domestic animals. Less is known to-day of the influence of different feeds and different combinations of feeds upon horses than upon any other class of our farm animals, and less attention has been given to study of the best methods of feeding and maintaining horses. Until recent years, and even to-day, the general feeding practices are fixed largely by tradition, custom or arbitrary rule Throughout the Middle West the common roughage for horses has been prairie hay. Thousands of acres of native grass in Kansas have been broken up, and from every indication it seems apparent that there will soon be a shortage of this class of rough feed. Oats of high quality, the standard grain for horses for many years, are becoming more difficult to obtain and are usually rather high in price. Some other grain must take the place of oats, in part at least, in compounding an economical and satisfactory ration for work horses.

OPPORTUNITY OFFERED AT FORT RILEY FOR HORSE FEEDING EXPERIMENT.

It is desirable in an experiment of this kind to have A large number of horses in each lot, in order to eliminate the factor of individuality, which so strongly influences the results obtained when only a very small number of individuals is used. The military post at Fort Riley offered an excellent opportunity for work of this kind. In this experiment the feeding was done in a practical manner, the work was regular and uniform in character, and large numbers of horses were used.

Historical Document
Kansas Agricultural Experiment Station

OBJECTS OF THE EXPERIMENT

The objects of the experiment were:

1. To make a direct comparison of the use of various hays for horse feeding, such as prairie, timothy, alfalfa, and small-grain hays.

2. To find, if possible, a grain or a mixture of grains that will take the place of oats for horse feeding and give the same results, and be more economical.

3. To make a careful study of the influence of various grains and mixtures of grain for standard horse rations.

GENERAL DISCUSSION.

HORSES USED.

The horses used in this experiment belonged to the United States Sixth field artillery, and averaged in weight about 1165 pounds. They ranged in age from five years up, the average age being about eleven years.

NATURE OF THE WORK.

There is no place where the work each horse performs is so uniform as in the army. Each horse does practically the same kind and same amount of work. The work performed during the experiment might properly be classed as rapid light draft. This consists chiefly of marching and drilling, the horses being hitched to heavy wagons and guns. A considerable portion of this work is done at a trot, and no small amount at a gallop. While the artillery horse performing his regular duties does not work so many hours a day as the farm horse during the busy season, the work he does is extremely fatiguing and is more severe than the average work done by the farm horse throughout the year. In considering the results of this experiment, it is not the intention to compare the work of the army horse with the work of the farm horse, but rather to compare the relative value of different feeds for horses under uniform conditions of work and care.

METHOD OF CARING FOR THE ARTILLERY HORSE.

The horses of each battery are under the direct charge of the stable sergeant, who is responsible for everything relating to the feeding and care of the horses of his battery. The men chosen for this responsible position are in every respect thor-

Historical Document
Kansas Agricultural Experiment Station

ough horsemen. Certain enlisted men are detailed to assist the stable sergeant, and are known as stable police. With such systematic and close supervision, these horses get excellent care. They are carefully fed, comfortably and sensibly housed, thoroughly groomed, and handled in a most practical manner. Regularity and punctuality are the rule. The discipline of the army makes this rule absolute, which helps wonderfully in keeping the army horse in excellent condition. The stables are clean, well lighted, well ventilated, free from drafts, and sanitary. The harness, especially the collars, is carefully fitted and kept clean.

WEIGHING.

These horses were weighed individually at the beginning of the experiment and at the end of each thirty-day period. Accurate records were kept of these weights.

GENERAL OBSERVATIONS.

Throughout the experiment careful observations were made as to the effect of the various feeds upon the general health, spirit and condition of the horses. Special attention was given to effect upon the respiratory and digestive organs.

SICK REPORT.

A careful sick report was kept, and all horses the iLlness of which was serious enough to put them off their feed for more than forty-eight hours, or to prevent them from doing their regular duties for a like period of time were eliminated in calculating results.

In the group of 937 horses, only fourteen cases of digestive disturbances were observed during the entire period. Of these fourteen cases, twelve were slight attacks of colic. The other two were severe cases of enteritis, resulting in death.

These digestive disturbances were reported from the following lots:

LOT 1.—One case of colic; mild.
LOT 2.—Three cases of colic; all mild.
LOT 3.—One case of colic; mild.
LOT 5.—One case of enteritis; fatal.
LOT 6.—Two cases of colic; mild.
LOT 7.—Two cases of colic; mild.
LOT 8.—Three cases of colic; mild.
LOT 8.—One case of enteritis; fatal.

Historical Document
Kansas Agricultural Experiment Station

METHODS OF ASCERTAINING THE AMOUNTS FED.

It was planned to feed each horse in each lot a specified amount of feed each day. The number of horses was so large, however, that it was found impossible to weigh out the ration for each horse at each feeding time. Consequently, the following method was adopted: The feed each lot of horses would eat for a period of ten days was calculated, weighed, and issued to the respective lots. At the end of each period of thirty days, the amount of feed on hand, if any, was deducted from the amount issued, which gave the amount to be charged to each lot for that thirty-day period. By dividing this amount by the number of horses and then by the number of days, the amount of feed each horse received daily was approximated. To insure uniform feeding at each feeding period, measures were used holding just one-third the amount planned to be fed daily to each horse. The system and the discipline were so excellent that it was possible to feed practically the amount planned for each lot. For instance, in Lot 6, where it was planned to feed four pounds of alfalfa meal a day, the actual amount was 4.01 pounds. The hay was baled, making it easy to feed the required amount.

METHOD OF FEEDING.

The horses were fed at 5:30 o'clock A. M., 11:30 o'clock A. M., and 5:30 o'clock P. M. One-third of the grain was fed at each meal and all the hay at night, except in Lots 13, 14, 16, and 17, where portions of the hay were fed at the morning and the noon meals. Where a mixture of grains was fed, the required amounts for each lot were thoroughly mixed just before feeding.

PRELIMINARY FEEDING.

Some of the feeds used in this experiment were so different from any these horses had ever eaten that it was thought advisable to accustom the horses gradually to the new rations, through a ten-day preliminary feeding period during which the new rations were gradually substituted for the old ration. At the end of ten days each lost was on full experimental feed.

COST OF VARIOUS FEEDS USED.

The stated cost of the various rations used in this experiment, except those containing small-grain hays, is based upon Kansas City prices at the time the feeds were purchased. The

Historical Document
Kansas Agricultural Experiment Station

small-grain hays were purchased f. o. b. San Francisco, at $10 a ton; the freight from San Francisco to Fort Riley was $20 a ton, making the total cost $30 a ton. On the above basis the feeds cost as follows: barley, 65 cents a bushel; corn, 55 cents a bushel; oats, 38½ cents a bushel; bran, $20 a ton; alfalfa meal, $14 a ton; timothy hay, $12.50 a ton; prairie hay, $12.50 a ton; alfalfa hay, $10 a ton; linseed meal, $35.50 a ton; brown sugar, $5 a hundredweight. Wheat hay, wild-oat hay and barley hay were each valued at $10 a ton. The values given for barley, corn, oats, bran, linseed meal, alfalfa hay and alfalfa meal are about the relative values usually prevailing in this locality. Prairie hay brings usually about the same price as alfalfa hay; timothy hay in this locality usually averages from 25 to 40 per cent higher in price than prairie hay.

Detailed Discussion.

Corn *vs.* oats.

Every horseman appreciates the value of oats as a feed for horses of every class and age, and especially for work horses. Usually oats is, however, from 20 to 35 per cent higher in price than corn. The question is, therefore, often asked, "Can as good results be obtained from feeding corn to work horses as from feeding oats?" On this question there seems to be a wide difference of opinion. The following results obtained from the Fort Riley experiment are interesting in this connection :

Lot No.	Number of horses	Average age of horses.	Number of days fed	Average weight of horses at beginning of test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
1	76	9.35	140	1,131.2	+16.3	Oats..... 10.51	Prairie hay, 12.25	1: 7.9	$0.2026
2	76	8.34	140	1,180.9	−29.3	Corn..... 10.27	Prairie hay, 11.98	1:11.5	.1754
11	18	14.00	140	1,181.6	−18.3	Oats 10.26	Prairie hay, 11.98	1: 7.9	.1980
5	69	11.00	110	1,196.8	−13.3	Oats..... 3.86 Corn..... 6.72	Prairie hay, 11.75	1:10.1	.1796

Historical Document
Kansas Agricultural Experiment Station

During the early part of the experiment, in January and February, while the weather was cold and the work only moderate, there was apparently no difference between the corn-fed and the oat-fed horses. The horses that received corn did their work and maintained their weight and condition just as well in every respect as the horses receiving oats; but as the weather grew warmer and the work became more severe, the corn-fed horses in Lot 2 began gradually to lose weight, and at the end of the experiment had lost 29.3 pounds to the horse, while the oat-fed horses in Lot 1 made a gain of 16.3 pounds to the horse. The horses of Lot 1, which were fed oats and prairie hay, received daily 10.51 pounds of grain and 12.25 pounds of prairie hay per thousand pounds live weight, while the horses of Lot 2, which were fed corn, received daily 10.27 pounds of grain and 11.98 pounds of prairie hay per thousand pounds live weight; that is, the horses of Lot 1, receiving oats and hay, were fed daily .24 pound of grain and .27 pound of hay more per thousand pounds live weight than the horses of Lot 2, receiving corn and prairie hay. While this difference is very small, it should be considered.

In Lot 11, in another battery, a smaller number of horses were fed the same ration as the horses in Lot I, namely, 10.26 pounds of oats and 11.98 pounds of prairie hay daily per thousand pounds live weight. Each horse in Lot 1 received daily .25 pound of oats and .27 pound of prairie hay per thousand pounds live weight more than each horse in Lot 11. The horses of Lot 1 made an average gain of 16.3 pounds during the experiment, while the horses in Lot 11 showed an average loss of 18.3 pounds. This difference is due, in all probability, to difference in the average ages of the horses in Lots 1 and 11. Those in Lot 1 averaged 9.35 years of age, none being extremely old, while those in Lot 11 averaged 14+ years of age, some horses being very old.

As the weather became warmer and the work more severe, the loss of weight in Lot 11 became pronounced, especially with the old horses in the lot. The horses in Lot 11, however, averaging fourteen years of age, maintained their weight better on a ration of oats and prairie hay than did the horses in Lot 2, averaging 8.34 years of age, on a ration of corn and prairie hay.

The results show that there is not a great difference in the

Historical Document
Kansas Agricultural Experiment Station

feeding value of corn and oats, with prairie hay for roughage, for mature horses doing light work during cold weather; but the horses did not maintain their weight nor stand hard work as well during hot weather when fed corn and prairie hay as when fed oats and prairie hay. Taking the ration fed in Lot 1 as a standard, and comparing the digestible nutrients of this ration with the digestible nutrients of the ration fed in Lot **2,** shown in the summary table, one will note that the ration of corn and prairie hay is deficient in digestible protein, and that to supply an amount of digestible protein equal to the amount of digestible protein in the standard ration fed in Lot 1, it would be necessary to substitute 1.37 pounds of corn for each pound of oats. In so doing an excessive amount of digestible carbohydrates and fat would be fed, Carbohydrates produce a large amount of heat in the processes of digestion, which fact explains the common observation that a ration of corn with either prairie or timothy hay is too heating to be fed work horses in hot weather. The presence of the hull in oats would seem to give them an advantage over corn, because of making a lighter and looser mass in the stomach. This makes them a safer feed, in that it overcomes to a considerable extent the tendency of food to pack in the stomach, and also allows the digestive juices to permeate the mass more thoroughly, thus insuring more nearly perfect digestion. The tendency to packing is more pronounced in a horse's stomach because of the absence of a churning or mixing motion. Because oats are less bulky than corn, there is also less danger of overfeeding oats.

There was apparently no difference in the endurance, the wind or the spirit of the horses in Lots 1 and 2. Both rations were satisfactory in this respect, but at the end of the experiment the corn-fed horses did not show quite so good condition and thrift as the oat-fed horses.

A comparison of results obtained in Lot 5 corroborates the deductions made from a study of Lots 1, 2, and 11.

In Lot 5 a grain ration of corn and oats with prairie hay was fed. By referring to the preceding table, we note that the corn and oats mixture gave better results than corn alone and prairie hay, but not so satisfactory results as oats alone and prairie hay, so far as maintaining the weight was concerned. No difference could be noted in spirit, endurance, or

Historical Document
Kansas Agricultural Experiment Station

wind. On a thousand-pound-live-weight basis the combination of oats one part, corn two parts, cost $0.0042 a day more than corn alone, and $0.023 a day less than oats alone.

CORN, BRAN, AND LINSEED MEAL *vs.* OATS.

Lot No.	Number of horses.....	Average age of horses.	Number of days fed..	Average weight of horses at beginning of test.....	Gain or loss per horse during test..	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio.....	Cost of daily ration per 1000 pounds live weight.....
		Years.		*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*		
1	76	9.35	140	1,131.2	+16.3	Oats..... 10.51	Prairie hay, 12.25	1: 7 9	$0.2026
15	22	12.00	140	1,159.3	+ 3.9	Corn..... 5.16 Bran..... 2.58 Lin. meal.. 0.86	Prairie hay, 12.05	1: 8.4	.1669

One of the most important problems that the average Kansas horse owner must meet is to find a satisfactory substitute for oats. In Lot 15 a combination of corn, bran and linseed meal in the proportion of 6:3:1 was used as a substitute for oats fed in Lot 1. It will be noted that 8.6 pounds of these mixed grains was substituted for 10.51 pounds of oats per thousand pounds live weight, or one pound of the mixed grains for 12 pounds of oats. The horses receiving the corn, bran, linseed meal and prairie hay made a gain of 3.9 pounds during the experiment. This ration proved to be practically as satisfactory a ration as the ration, consisting of oats and prairie hay, fed to the horses in Lot 1. While the horses in Lot 15 did not make quite so great gains as those in Lot 1, they showed a trifle better condition, and their wind, endurance and spirit were just as good. The daily ration fed in Lot 15 (corn, bran, linseed meal, and prairie hay) was $0.0257, or practically 12 per cent, cheaper per thousand pounds live weight than the ration fed in Lot 1 (oats and prairie hay). The ration fed in Lot 15 has been used at the Kansas State Agricultural College for a number of years, and has proved a very satisfactory ration for work horses.

Historical Document
Kansas Agricultural Experiment Station

BRAN *vs.* LINSEED MEAL.

Lot No.	Number of horses	Average age of horses	Number of days fed	Average weight of horses at beginning of test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
8	75	11.86	110	1,170.5	—8.7	Oats ..... 8.39 Corn..... 5.10 Bran..... 3.39	Prairie hay, 10.20	1: 8.3	$0.1877
10	77	10.00	110	1,170.0	—2.5	Oats ..... 8.41 Corn..... 5.11 Lin. meal... 0.85	Prairie hay, 10.23	1: 8.3	.1700

The horses in Lots 8 and 10 received daily practically the same number of pounds of corn, oats and prairie hay per thousand pounds live weight. In addition to the corn, oats and prairie hay fed to each lot, the horses in Lot 8 received daily 3.39 pounds of bran per thousand pounds live weight, and the horses in Lot 10 received daily .85 pound of old-process linseed meal per thousand pounds live weight. In other words, four pounds of bran was replaced by one pound old-process linseed meal. There was very little difference in the matter of maintenance of weight, and no difference in endurance, spirit, or wind, but the horses of Lot 10 showed a better coat of hair, indicating better thrift. It would seem that one pound of old-process linseed meal, when fed with corn, oats and prairie hay, is equal to four pounds of bran. The amount of linseed meal fed in this experiment did not result in undue looseness of the bowels, so for most satisfactory results about one pound of linseed meal per thousand pounds live weight should be fed a work horse. More than this amount would probably result in a too laxative effect.

There is a value in linseed meal as a feed for horses aside from simply the digestible nutrients it contains. It seems to stimulate all the digestive organs and act as a tonic, and evidently plays some part in increasing the digestibility of some feeds. The use of one pound of linseed meal in place of four pounds of bran reduced the daily cost of feed $0.0177 per thousand pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

OATS *vs.* BARLEY.

Lot No.	Number of horses	Average age of horses.	Number of days fed	Average weight of horses at beginning of test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
1	76	9.35	140	1,182.2	+16.3	Oats..... 10.51	Prairie hay, 12.52	1: 7.9	$0.2026
11A	3	9.00	140	1,100.0	+8.3	Barley..... 10.86	Prairie hay, 12.68	1:10.3	.2258

Because of the small number of horses receiving this ration, not a great deal of emphasis is put upon the results obtained from feeding barley in this experiment. When the order for the various feeds was approved, an error was made in estimating the number of pounds of barley needed, hence only a small amount was purchased. It was therefore thought best to feed a small number of horses on a barley ration for a long period rather than a large number of horses for only a short time. Even with the small number of horses used, we can safely say that for maintenance of weight one pound of barley is worth almost as much as one pound of oats, but apparently barley-fed horses will not show so good condition as oat-fed horses. A conspicuous feature is the expense, which makes the use of barley prohibitive under average Kansas conditions.

BROWN SUGAR *vs.* OATS.

Lot No.	Number of horses	Average age of horses.	Number of days fed	Average weight of horses at beginning o test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
11	18	14.00	75	1,181.6	−21.6	Oats..... 10.26	Prairie hay, 11.98	1: 7.9	$0.1980
18	18	12.50	75	1,197.7	−17.7	Oats..... 8.32 Br. sugar.... 0.42	Prairie hay, 11.65	1: 8.5	.1936

Brown sugar was fed for only seventy-five days, so comparisons are made with results obtained in Lot 11 for a period of seventy-five days.

Historical Document
Kansas Agricultural Experiment Station

The horses in .Lots 11 and 18 were in the same battery, were fed by the same men, and did the same work. One-half pound of brown sugar was substituted for two pounds of oats. The horses in Lot 11 showed an average loss of 21.6 pounds at the end of the period of seventy-five days, while the horses in Lot 18 showed an average loss of 17.7 pounds. The horses in Lot 11 averaged fourteen years of age; the horses in Lot 18, twelve and one-half years. Because of the fact that their ages averaged so nearly the same, Lot 11 is used in making comparisons, instead of Lot 1, which was composed of a younger lot of horses and which made a gain of fifteen pounds during the first seventy-five days of the experiment. The horses of Lot 18 showed excellent coats of hair and good appetites, but seemed to sweat more easily and more profusely than the horses of any other lot.

A small amount of sugar may be fed as an appetizer or conditioner, but is not a practical or economical substitute for the various grains which are ordinarily available for horse-feeding purposes.

ALFALFA MEAL *vs.* BRAN.

Lot No.	Number of horses	Average age of horses.	Number of days fed	Average weight of horses at beginning of test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight.
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
6	73	11.3	110	1,177.7	−8.3	Oats..... 3.41 Corn..... 5.11 Alf. meal... 3.41	Prairie hay, 10.23	1:8.3	$0.1787
8	75	11.86	110	1,170.5	−6.7	Oats..... 3.39 Corn..... 5.10 Bran 3.39	Prairie hay, 10.12	1:8.3	.1877
7	79	11.00	110	1,156.0	+3.0	Oats..... 3.44 Corn..... 5.16 Alf. meal... 3.44	Timothy ... 10.34	1:8.3	.1805
9	76	10.40	110	1,167.4	+6.1	Oats..... 3.39 Corn..... 5.08 Bran 3.39	Timothy... 10.17	1:8.3	.1880

The value of bran as a horse feed has long been recognized, and a comparison of alfalfa meal with bran will probably give as practical an idea as can be given of the feeding value of the latter. A study of the results in Lots 6 and 8, and in Lots 7 and 9, will show that, so far as maintaining weight is

Historical Document
Kansas Agricultural Experiment Station

concerned, one pound of alfalfa meal is almost equal in feeding value to one pound of bran, and lessens the daily cost about one cent per thousand pounds live weight. There are, however, some objections to its use as a horse feed. It is a disagreeable feed to handle, because, as it is finely pulverized and very light, a large part of it rises in a cloud of dust whenever handled in bulk. If fed dry, even when mixed with other feeds, a large amount of this dust is continually getting into the air passages of the horse. The mucous membranes lining these passages are tender and easily irritated, and the use of dry alfalfa meal for any length of time may cause serious irritation and inflammation of the respiratory tract. This objection may be overcome by wetting the alfalfa meal, but to prevent souring or molding, this wetting must be done immediately before feeding. This is a task involving no little time and inconvenience, especially in winter.

The horses ate the wet alfalfa meal, but did not seem to relish it. Another objection is the fact that one does not know what kind of hay he is getting when it is bought in the form of alfalfa meal. Most mills are putting out a very good quality of meal, but wet, moldy, and even rotten hay, is sometimes ground into meal. It has been claimed that much less is wasted in feeding alfalfa in the form of meal than in the form of hay; but if the hay is properly fed, very little, if any, will be wasted. This proposition will be discussed in detail under the subject of alfalfa hay. The alfalfa meal used in this experiment cost $4 a ton more than the alfalfa hay. Often the difference is as much as $6 a ton.

The results obtained in this experiment show that alfalfa in the form of meal is not a desirable nor an economical feed to use when alfalfa in the form of hay is available.

ALFALFA HAY, CORN AND OATS *vs.* OATS AND PRAIRIE HAY.

Lot No.	Number of horses.....	Average age of horses.	Number of days fed.	Average weight of horses at beginning of test.....	Gain or loss per horse during test....	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio.....	Cost of daily ration per 1000 pounds live weight.....
		Years.		*Lbs.*	*Lbs.*				
1	76	9.35	140	1,131.2	+16.3	Oats..... *Lbs.* 10.51	Prairie hay, *Lbs.* 12.25	1: 7.9	$0.2026
12	17	12 00	140	1,163.2	+25.6	Oats..... 1.70 Corn..... 6.80	Alfalfa hay, 8.50	1: 5.8	.1295

Historical Document
Kansas Agricultural Experiment Station

Better results might be expected from the horses of Lot 1 than from those of Lot 12, because the former were younger and received more grain. However, the horses in Lot 12, receiving the combination of corn with a very small amount of oats and alfalfa hay, did their work just as well in every respect as the horses in Lot 1; they showed no signs of shortness of wind, softness, lack of endurance, laxative effect or excessive urination, and made a gain of 25.6 pounds per horse during the experiment. The feed cost daily only $0.1295 per thousand pounds live weight, or 36 per cent less than the ration consisting of oats and prairie hay. The amount of grain was reduced 19 per cent and the amount of hay 30 per cent. It will be noticed that a very small amount of alfalfa hay was fed, wherein lies the principal secret of feeding alfalfa hay to work horses. It should be looked upon more as a concentrate than as a roughage, and should be fed in limited amounts.

This question will be discussed more in detail a few pages farther on.

Corn and alfalfa, being digested readily, do not require an excessive amount of energy for digestion, which fact is one reason for the good results obtained in Lot 12, with a ration in which the nutritive ratio is comparatively narrow.

As prairie and timothy hay are often allowed to become too mature before cutting, the digestible nutrients are so strongly encased in a cellulose envelope that an excessive amount of energy must be expended in digesting these hays and making the digestible nutrients available. This demands a larger percentage of energy-producing elements, and hence a wider nutritive ratio. It is seen that the ease with which the feeds of a ration are digested has considerable influence upon the nutritive ratio required. For instance, one pound of alfalfa hay contains .453 pound of digestible nutrients, requiring .219 pound of available digestible nutrients for mastication and digestion, leaving .234 pound of available digestible nutrients. On the other hand, one pound of average wheat straw contains .181 pound of digestible nutrients, requiring .297 pound digestible nutrients for digestion and mastication, leaving —.116 pound digestible nutrients.

Historical Document
Kansas Agricultural Experiment Station

ALFALFA MEAL AS A PARTIAL SUBSTITUTE FOR CORN AND OATS.

Lot No.	Number of horses....	Average age of horses.	Number of days fed..	Average weight of horses at beginning of test.....	Gain or loss per horse during t st...	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio.....	Cost of daily ration per 1000 pounds live weight.....
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
5	69	11	110	1,196.8	−13.3	Oats..... 3.86 Corn..... 6.72	Prairie hay, 11.75	:10.1	$0.1796
6	73	11.3	110	1,177.7	− 8.3	Oats ..... 3.41 Corn..... 5.11 Alf. meal... 3.41	Prairie hay, 10.23	1: 8.3	.1787

Four pounds of alfalfa meal was substituted for two pounds of corn and two pounds of prairie hay. The horses receiving this substitution maintained their weight somewhat better than those in Lot 5, which received corn, oats, and prairie hay. So far as the nutritive value of alfalfa meal is concerned, it is a satisfactory feed; but, in view of the objections already mentioned, alfalfa hay of the right kind should be used instead. There was practically no reduction in the cost of the ration, when fed in the form of meal, but if hay had been fed there would have been a slight reduction in the daily cost per thousand pounds live weight. From the results shown by Lots 5 and 6, it is seen that for at least a part of the grain ration, two pounds of alfalfa, when fed with prairie or timothy hay, may be substituted for one pound of corn in a ration for a work horse.

ALFALFA HAY *vs.* PRAIRIE HAY.

Table A.

Lot No.	Number of horses...	Average age of horses.	Number of days fed..	Average weight of horses at beginning of test.....	Gain or loss per horse during test...	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight.....
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
12	17	12	140	1,168.2	+25.6	Oats..... 1.7 Corn..... 6.8	Alfalfa hay.. 8.5	1: 5.8	$0.1295
2	76	8.34	140	1,180.9	−29.3	Corn..... 10.27	Prairie hay, 11.98	1:11.5	.1754

Historical Document
Kansas Agricultural Experiment Station

The horses in Lot 12 did their work in a very satisfactory manner. They showed better condition than the horses in Lot 2, and made a gain of 25.6 pounds per horse, while the horses in Lot 2 lost 29.3 pounds per horse during the test. In Lot 12 the grain fed daily per thousand pounds live weight was reduced 17.23 per cent, the hay 29.1 per cent, and the cost of the daily ration per thousand pounds live weight 26.2 per cent. To repeat, here was fed a ration satisfactory in every respect and 26.2 per cent cheaper than a ration commonly fed.

Table B.

Lot No.	Number of horses.....	Average age of horses.	Number of days fed..	Average weight of horses at beginning of test.....	Gain or loss per horse during test...	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio.....	Cost of daily ration per 1000 pounds live weight.....
		Yrs		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
12	17	12	140	1,163.2	−25.6	Oats..... 1.70 Corn..... 6.80	Alfalfa hay.. 8.50	1: 5.8	$0.1295
5	69	11	110	1,196.8	−13.3	Oats ..... 3.36 Corn..... 6.72	Prairie hay.. 11.75	1:10.1	.1796

The horses in Lots 5 and 12 received daily practically the same amounts of corn per thousand pounds live weight. In addition to the corn, the horses in Lot 5 received daily 3.36 pounds of oats per thousand pounds live weight, while the horses in Lot 12 received daily, in addition to the corn, only 1.7 pounds of oats per thousand pounds live weight. Thus the horses in Lot 5 received daily 10.08 pounds of grain, while those in Lot 12 received daily 8.5 pounds of grain per thousand pounds live weight. The horses in Lot 5, receiving 10.08 pounds of grain, were fed daily 11.75 pounds of prairie hay per thousand pounds live weight, while the horses in Lot 12, receiving 8.5 pounds of grain, were fed daily only 8.5 pounds of alfalfa hay per thousand pounds live weight. The horses in Lot 12, receiving the smaller amounts of both grain and hay, showed better thrift and condition than those in Lot 5, did their work just as well in every respect, and made a gain of 25.6 pounds per horse, while those in Lot 5 showed a loss of 13.3 pounds per horse. The ration used in Lot 12 resulted in a reduction of 15.67 per cent in the grain portion of the daily ration per thousand pounds live weight, and 27.7 per

Historical Document
Kansas Agricultural Experiment Station

cent in the hay. In the two comparisons above, the substitution of alfalfa hay reduced the amount of hay required almost 30 per cent, at the same time reducing the amount of grain, on an average, about 16 per cent. While these results do not give a direct comparison in the value of alfalfa and prairie hay, one is yet justified in concluding that in a properly balanced ration one pound of alfalfa hay is probably worth two pounds of prairie or timothy hay.

ALFALFA HAY AS A HORSE FEED.

The results obtained from the use of alfalfa hay in this experiment are probably the most interesting, practical and valuable part of the whole experiment, because of the general prejudice against feeding alfalfa to work horses, and because of the richness, the cheapness and the plenteousness of alfalfa hay in most parts of Kansas. If alfalfa hay *is properly fed,* it may be fed to any kind of horses; this applies just as strongly to work horses as to growing horses. In order, however, to be fed successfully, it must be cut at the proper time for horse-feeding purposes, and must be fed as a concentrate rather than as a roughage.

The method practiced by a majority of those who have fed alfalfa to work horses in the past, and even of those who feed it at present, has been to fill the manger morning, noon and night, thus allowing the horse to eat all he wished. Prairie hay has been fed in this way without any serious results. Alfalfa hay being very palatable, horses eat very large amounts, and the results are: excessive urination, and soft, "windy" horses that are puffed in the hocks, stocked in the legs, and unable to stand hard work. A verdict that alfalfa hay was absolutely unfit to feed a work horse is the result. This has been the experience of hundreds of horsemen, but the trouble was with the method of feeding, not with the alfalfa hay.

It has been said that the proper time to begin cutting alfalfa hay is when the field is about one-tenth in bloom. Cutting at such a time makes very good hay for cattle, but such hay is too "washy" for horses at hard work. To make hay suitable for horses at hard work, the alfalfa hay must be allowed to get rather mature before cutting; in fact, the field should be in full bloom before the mower is started. The hay should then be properly cured and stacked. Special care must be

Historical Document
Kansas Agricultural Experiment Station

taken to prevent spoiling or molding, as moldy, musty or dusty hay of any kind is injurious to horses.

After the hay has been cut at the right time and properly cared for, the next consideration is the amount to be fed daily. Probably the most important cause of so much trouble in feeding alfalfa hay has been overfeeding. On the average, one pound of alfalfa hay contains 35 per cent more digestible protein than one pound of shelled corn, and is fairly rich in carbohydrates and fat. A person would not think of feeding a 1200-pound work horse a bushel (56 pounds) of shelled corn in a day, yet by giving the same horse all the alfalfa hay he will eat, as large or a larger amount of digestible protein will be fed daily than is contained in a bushel of shelled corn. When large amounts of alfalfa are fed, the horse receives an excessive amount of highly nitrogenous material. This not only overworks the kidneys, but also causes irritation which may result in a pronounced chronic inflammatory condition of the kidneys if excessive feeding of alfalfa is continued for a long time. Another effect of *overfeeding* with alfalfa is a sort of cloying of the whole system, resulting in impaired nutrition, filling of the legs and hocks, softness, excessive sweating, and impaired respiration. A part of the trouble with the wind comes from the fact that the overloaded digestive tract interferes with the proper functioning of the lungs, and heaves may develop, as most cases of heaves result from indigestion, the disease being at first functional, but later becoming a structural disturbance, which is incurable.

This shows that, if alfalfa is not fed properly, it will not prove satisfactory. If it is fed properly, it is the most valuable horse feed available for the average Kansas farmer. Again, the things to remember in feeding alfalfa hay to work horses are: first, the hay must not be cut until quite mature; second, it must be free from dust, mold, or smut; third, it must be fed in limited quantities. As to the amount to be fed, experience seems to indicate that one and one-fifth pounds per hundred pounds live weight is about the maximum amount for work horses.

Because of its high proportion of digestible protein, alfalfa balances very well with corn, and these two feeds make the most economical ration the Kansas farmer who grows alfalfa can feed, and probably as satisfactory as any, for the farmer

Historical Document
Kansas Agricultural Experiment Station

can control the time of cutting and the manner of curing and caring for the hay.

The man who buys alfalfa hay on the market usually chooses the hay showing the brightest green color, which is often the poorest for work horses, because it has been cut too green and will be very "washy." If, however, he will purchase average, well-cured, clean alfalfa hay, he mill be able to reduce the cost of feed very materially by substituting alfalfa hay for a part of the prairie or timothy hay. He may substitute one pound of alfalfa hay for one and one-half to two pounds of prairie or timothy hay, until from one-third to one-half or more of the prairie or timothy hay has been replaced by alfalfa hay, the amount used depending upon the quality of the alfalfa substituted for the other hays. The grain ration, too, may be cut down, as shown by the results obtained in Lots 2, 5, and 12.

TIMOTHY HAY *vs.* PRAIRIE HAY.

Lot No.	Number of horses	Average age of horses.	Number of days fed	Average weight of horses at beginning of test	Gain or loss per horse during test	Grain daily per 1000 pounds live weight.	Hay daily per 1000 pounds live weight.	Nutritive ratio	Cost of daily ration per 1000 pounds live weight
		Years.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*		
3	74	10.44	140	1,185.	—12.9	Oats..... 6 78 Corn..... 3.39	Prairie hay, 11.86	1: 8.9	$0.1886
4	76	11.00	140	1,159.6	— 7.7	Oats..... 6.90 Corn..... 3.45	Timothy... 12.08	1: 9.	.1921
6	73	11.3	110	1,177.7	— 8.3	Oats..... 3.41 Corn..... 5.11 Alf. meal... 3.41	Prairie hay, 10.23	1: 8.3	.1787
7	79	11.0	110	1,156.	+ 3.0	Oats..... 3.44 Corn..... 5.16 Alf. meal... 3.44	Timothy.... 10.34	1: 8.3	.1805
8	75	11.86	110	1,170.5	— 6.7	Oats..... 3.39 Corn..... 5.10 Bran..... 3.39	Prairie hay, 10.12	1: 8.3	.1877
9	76	10.4	110	1,167.4	+ 6.1	Oats..... 3.39 Corn..... 5.09 Bran..... 3.39	Timothy... 10.17	1: 8.3	.1880

While neither the timothy hay nor the prairie hay used in this experiment was of the best quality, the timothy hay proved to be slightly superior to the prairie hay as a feed for work horses. In Lots 3 and 4, the horses belonged to the same battery, were all housed under the same roof, received the same

Historical Document
Kansas Agricultural Experiment Station

grain ration, and did the same kind and amount of work. In fact, in most instances the teams consisted of a horse from each lot. The timothy-fed horses maintained their weight slightly better than the horses fed with prairie hay.

The horses in Lots 6 and 7 did practically the same kind and amount of work, but were in different batteries and different barns, and were fed by different sets of men. The results are practically the same as in Lots 3 and 4.

The horses in Lots 8 and 9 were in different batteries and different barns, and were fed by different sets of men. Here, too, the results were practically the same as obtained in Lots 3 and 4 under identically the same conditions.

In this experiment timothy and prairie hay were compared when fed with three different grain rations: first, oats and corn; second, oats, corn, and alfalfa meal; third, oats, corn, and bran. In each case the horses receiving the timothy hay maintained their weight a trifle better than those receiving prairie hay.

At the time these hays were purchased, timothy and prairie hay were quoted at the same price in Kansas City, but this is unusual. Generally timothy hay is quoted at from 20 per cent to 40 per cent higher than prairie hay of equal grade, while in many parts of the state timothy hay is not available at all. The results of this experiment would indicate that, when the two hays are available at the same price, timothy is more desirable, but that if the timothy costs 10 per cent more per ton than prairie hay, the prairie hay will be more economical to use. Many times both timothy and prairie hay are allowed to become too mature before cutting. It is just as undesirable to cut the hay too mature as it is to cut it too green. In one case the hay will be coarse, woody, and indigestible, while in the other it will be light and "washy."

SMALL-GRAIN HAY.

It was planned to make a thorough test of the feeding value for work horses of the following small-grain hays: oat hay, wheat hay, barley hay. Owing, however, to a misunderstanding in arranging the experiment, only a limited amount of these hays was ordered; and, as no very extensive work could be done with the amount available, the results obtained are not definite or conclusive, and will be omitted.

In at least the eastern half of Kansas, these hays may be

Historical Document
Kansas Agricultural Experiment Station

raised. Oftentimes, especially during years immediately following a shortage in the hay crop, small-grain hays may be grown very profitably. It is generally conceded that these hays make excellent roughage for work horses, and that, if they are properly cured, their feeding value is higher than that of either timothy or prairie hay.

SOME FUNDAMENTAL PRINCIPLES OF FEEDING.

The functions of food are to repair the waste of the body, to promote growth in an animal, to furnish heat and energy, and to store up or lay on fat. Only the digestible portions of the food are available for these purposes. The nutrients that serve these purposes are protein, carbohydrates, and fat. A definite amount of each of these nutrients is required to insure the most economical performance of these functions, a shortage or an excess of any one meaning an unbalanced ration and a waste both actual and potential. Too often the wrong concentrate is used, because its composition and the function of the nutrients it contains are not clearly understood. It is well, then, to note carefully just what part each of these nutrients plays in maintaining these functions :

1. Protein substances are those which contain the element of nitrogen. The other nutrients — carbohydrates and fat — contain no nitrogen and are spoken of as nonnitrogenous nutrients. Protein substances, or flesh-builders, as they are often called, go to form the muscles, and also enter largely into the composition of the skin, tendons, blood, nervous system, hair, internal organs, foetus, etc.

Protein may also furnish, when occasion requires, muscular energy, and some material for the production of heat to maintain the warmth of the body. It is held by many to be a stimulant to muscular and functional activities in general, and may form body fat. It acts also as an appetizer.

No substance that does not contain nitrogen can be substituted for or converted into protein. Hence, the absolute necessity for a certain amount of protein material in a horse's ration. Such feeds as cottonseed meal, linseed meal, peas, bran, shorts, alfalfa, clover and cowpea hay contain comparatively high proportions of digestible protein.

2. Carbohydrates furnish much of the energy for the production of heat and work by an animal, and are obtained from the various feeds in the form of starch, sugar, and fiber, or

Historical Document
Kansas Agricultural Experiment Station

cellulose. They are converted principally into glycogen, a carbohydrate resembling starch, which is stored in the liver and muscular tissues of the animal. When this glycogen is needed it is converted into a glucose, which is soluble, and passes into the blood. Some of the carbohydrates may be converted into fat and some may be burned to supply heat or muscular energy. Corn, barley, oats, wheat, kafir and the various hays and fodders contain high proportions of digestible carbohydrates.

3. Fat is found in the various feeds in smaller amounts than either protein or carbohydrates. It is either stored up in the body as fat or burned to furnish heat and energy. Cottonseed meal and linseed meal are rich in fat, cottonseed meal containing about three times as much digestible fat as corn.

It is seen, therefore, that heat and muscular energy may be produced, first from carbohydrates, secondly from fats, and, lastly, to a certain extent, from protein substances. One pound of digestible fat is worth about 2.24 times as much as one pound of digestible protein or one pound of digestible carbohydrates in the production of heat and muscular energy. Fat in the body is produced from the fat and the carbohydrates of the food eaten, and probably to a certain extent from the protein.

4. Ash is also a necessary constituent of a satisfactory ration. It is the residue after the combustible portion of feeding stuffs has been burned in the body. It consists chiefly of lime, phosphorus, iron, potash, magnesia, soda, sulphur, etc., and is found principally in the bones, though in small quantities in other tissues of the body. A considerable supply of ash is found in all coarse feeding stuffs; hence this constituent does not cause so much concern as do protein, carbohydrates, and fat. In a ration consisting principally of grain, it may be necessary to give attention to insuring a supply of ash.

Historical Document
Kansas Agricultural Experiment Station

SUMMARY OF

Lot No.	Number of horses	Average age of horses	Number of days fed	Average weight of horses at beginning of test, January 15, 1911	Average weight of horses at end of test	Gain or loss of horses during the test	Daily ration per horse.		Grain daily per 1000 pounds live weight.	
								Lbs.		*Lbs.*
1	76	*Years.* 9.35	140	*Lbs.* 1,131.2	*Lbs.* 1,147.5	*Lbs.* +16.3	Oats	12	Oats	10.51
							Prairie hay	14		
2	76	8.34	140	1,180.9	1,151.6	−29.3	Corn	12	Corn	10.27
							Prairie hay	14		
3	74	10.44	140	1,185.0	1,172.1	−12.9	Oats	8	Oats	6.78
							Corn	4	Corn	3.39
							Prairie hay	14		
4	76	11.00	140	1,159.3	1,151.6	− 7.7	Oats	8	Oats	6.90
							Corn	4	Corn	3.45
							Timothy hay	14		
5	69	11.00	110	1,196.8	1,183.5	−13.3	Oats	4	Oats	3.36
							Corn	8	Corn	6.72
							Prairie hay	14		
6	73	11.30	110	1,177.7	1,169.4	− 8.3	Oats	4	Oats	3.41
							Corn	6	Corn	5.11
							Alfalfa meal	4	Alfalfa meal	3.41
							Prairie hay	12		
7	79	11.00	110	1,153.0	1,156.0	+ 3.0	Oats	4	Oats	3.44
							Corn	6	Corn	5.16
							Alfalfa meal	4	Alfalfa meal	3.44
							Timothy hay	12		
8	75	11.86	110	1,170.5	1,163.8	− 6.7	Oats	4	Oats	3.39
							Corn	6	Corn	5.10
							Bran	4	Bran	3.39
							Prairie hay	12		
9	76	10.40	110	1,167.4	1,173.5	+ 6.1	Oats	4	Oats	3.39
							Corn	6	Corn	5.09
							Bran	4	Bran	3.39
							Timothy hay	12		
10	77	10.00	110	1,170.0	1,167.5	− 2.5	Oats	4	Oats	3.41
							Corn	6	Corn	5.11
							Linseed meal	1	Linseed meal	.85
							Prairie hay	12		
11	18	14.00	140	1,181.6	1,163.3	−18.3	Oats	12	Oats	10.26
							Prairie hay	14		
11A	3	9.00	140	1,100.0	1,108.3	+ 8.3	Barley	12	Barley	10.86
							Prairie hay	14		
12	17	12.00	140	1,163.2	1,188.8	+25.6	Corn	8	Corn	6.80
							Oats	2	Oats	1.70
							Alfalfa hay	10		
15	22	12.00	140	1,159.3	1,163.2	+ 3.9	Corn	6	Corn	5.16
							Bran	3	Bran	2.58
							Linseed meal	1	Linseed meal	.86
							Prairie hay	14		
18	18	12.50	75	1,197.7	1,180.0	−17.7	Oats	10	Oats	8.32
							Brown sugar	.5	Brown sugar	.42
							Prairie hay	14		

Historical Document
Kansas Agricultural Experiment Station

EXPERIMENTS.

Hay daily per 1000 pounds live weight.	Digestible nutrients per day per 1000 pounds live weight.			Total digestible nutrients per day per 1000 pounds live weight.	Nutritive ratio	Cost of grain per day per 1000 pounds live weight.	Cost of hay per day per 1000 pounds live weight.	Total cost per day per 1000 pounds live weight.	Lot No.
	Protein.	Carbohydrates.	Fat.						
Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*					
Prairie hay 12.25	1.492	10.542	.595	12.629	1: 7.9	$0.1261	$0.0765	$0.2026	1
Prairie hay 11.98	1.160	11.999	.633	13.792	1:11.5	.1006	.0748	.1754	2
Prairie hay 11.86	1.345	10.762	593	12.700	1: 8.9	.1145	.0741	.1886	3
Timothy hay..... 12.08	1.345	10.897	.567	12.809	1: 9.0	.1166	.0755	.1921	4
Prairie hay 11.75	1.236	11.219	.604	13.059	1:10.1	.1062	.0734	.1796	5
Prairie hay 10.22	1.448	10.846	.533	12.827	1: 8.3	.1148	.0639	.1787	6
Timothy hay..... 10.34	1.441	10.906	.517	12.864	1: 8 3	.1159	.0646	.1805	7
Prairie hay. 10.12	1.467	10.877	.594	12.938	1: 8.3	.1245	.0632	.1877	8
Timothy hay..... 10.17	1.449	10.847	.565	12.861	1: 8 3	.1245	.0635	.1880	9
Prairie hay 10.23	1.327	9.789	.571	11.687	1: 8 3	.1061	.0639	.1700	10
Prairie hay 11.98	1.457	10.300	.581	12.338	1: 7.9	.1231	.0749	.1980	11
Prairie hay 12.68	1.292	12.581	.376	14.199	1:10.3	.1466	.0792	.2258	11A
Alfalfa hay..... 8.50	1.655	8.721	.408	10.784	1: 5.8	.0870	.0425	.1295	12
Prairie hay 12.05	1.330	9.975	.538	11.843	1: 8.4	.0916	.0753	.1669	15
Prairie hay 11.65	1.239	9.455	.502	11.196	1: 8.5	.1208	.0728	.1936	18

Historical Document
Kansas Agricultural Experiment Station

DIGESTIBLE NUTRIENT VALUES USED IN FIGURING RESULTS.

	Total dry matter.	Total ash.	Digestible crude protein.	Digestible carbohydrates.	Digestible fat.
Corn (Dent)	89.4%	1.5%	7.8%	66.8%	4.3%
Oats	89.6	3.2	10.7	50.3	3.8
Barley	89.2	2.5	8.4	65.3	1.6
Bran	88.1	5.8	11.9	42	2.5
Alfalfa meal or hay,	93.2	10.6	11.1	39.1	.6
Linseed meal (O. P.),	90.2	5.5	30.2	32	6.9
Prairie hay	90.8	7.8	3	42.9	1.6
Timothy hay	86.8	4.4	2.8	42.4	1.3
Barley hay	85	4.2	5.7	43.6	1
Wild-oat hay	85.7	3.8	2.9	48.7	1.7
Oat hay	86	5.7	4.7	36.7	1.7
Wheat hay (Club)..	91.2		3.6	46.1	1.1

AVERAGE EQUIVALENTS IN QUARTS
OF ONE POUND OF EACH OF THE MORE COMMON GRAINS.

One pound of corn equals	0.6	quarts	(approximately)
" " " oats equals	1	"	"
" " " barley equals	0.7	"	"
" " " bran equals	2	"	"
" " " alfalfa meal equals	2	"	"
" " " linseed meal equals	0.5	"	"

THE FEED AND CARE OF THE STALLION.

The stallion probably receives less intelligent care and attention from the average stallion owner than any other kind of property of equal value. Very frequently, if mention is made of a desire to look over a stallion after the breeding season, the owner at once begins to apologize for his appearance, for the place in which he is kept, and for the manner in which he is handled; and in such cases the stallion is usually found in a small, dark, unclean stall in some isolated portion of the barn. Here he spends his time in idleness, away from all association with other horses and with men. It is just this kind of treatment that causes so many stallions to become weak-eyed, bad-tempered, and unruly, to contract so many vicious habits, and to get such a small per cent of colts from the number of mares bred. Prepotency, vigor and health are the qualities that a stallion must possess before he can be a success as a breeder and a paying investment for the owner. The owner can maintain and strengthen, or he can ruin these necessary qualities. If he expects his stallion to be prepotent, strong, vigorous and healthy, he must see that the stallion receives plenty of exercise and is properly fed and intelligently handled.

Historical Document
Kansas Agricultural Experiment Station

The very first consideration is exercise, yet there is nothing more neglected. Hundreds of stallions are not permitted to leave their boxes from the end of one breeding season to the beginning of the next, even the water being carried to them; and there are hundreds of other stallions the owners of which imagine that sufficient exercise may be obtained in a lot twelve by twenty feet in size. Every stallion must have plenty of exercise. It gives life and vigor to the germs of reproduction, tones up the muscles, stimulates the circulation and digestion, gives strength and vitality to every tissue and every organ of the body. On the other hand, lack of exercise causes degeneration, and loss of strength and vitality.

The best kind of exercise for a stallion is good, honest work. Several Kansas stallion owners are working pairs of stallions on their farms, and these stallions are proving to be wonderfully sure breeders. It would not be practical to suggest that every one work stallions together, but rather that a stallion be worked with a gelding or a mare, as this practice would be safer and more satisfactory.

Of course, one must use care and judgment in working stallions. They are big, strong and willing, but are usually soft and fat from lack of exercise, and therefore can not stand continued hard work when first put to it. Consequently, one should begin with light work, only a few hours each day, gradually increasing the work until the stallion is able to do daily a full day's work outside of the breeding season. At least half a day's work each day during the breeding season would be beneficial.

By working a stallion one directs his excessive energy into useful channels, and he becomes stronger, more vigorous, more tractable, easier to control, and more agreeable to handle, as well as a better breeder.

If there is any good reason why a stallion can not be worked, he should be given exercise on the road—not a long, hard, wearisome jog once every week or ten days, but several miles every day. For a draft horse, five or six miles is sufficient; for a roadster, probably a few miles more, depending upon the condition of the roads and the weather. It should be remembered that there must be regular exercise and plenty of it.

The next consideration is the question of feeding. If the stallion is given the proper amount of exercise, the feeding

Historical Document
Kansas Agricultural Experiment Station

problem will usually be much less troublesome. In feeding, it is not so much a question what to feed as how to feed. The first requisite to successful feeding is regularity. The stallion should be fed three times a day and at the same hours each day. He should, moreover, have plenty of pure, clean, fresh water. The ration will depend largely upon the feeds available in a particular locality, but, of course, in consideration of the amount invested in a good stallion, the little extra expense necessary to get feeds known to be well adapted for stallion-feeding purposes is a small item. No specific directions can be given in regard to the amount to be fed. This depends upon the individuality of the stallion. Every stallion owner knows that some stallions are "easy keepers" and some "hard keepers"; some keeping fat upon a ration upon which another stallion of equal size would remain thin. A good, wholesome ration should be selected and enough should be fed to keep the stallion in fairly good flesh, but not hog fat. During the breeding season one should aim to keep him gaining just a little each day; then one may know that he is getting a sufficient amount of food. Drugs and patent stock foods are expensive and can not take the place of exercise and wholesome food. In the end they may leave harmful effects.

A few combinations of feeds that might be suggested as rations for a stallion are as follows:

1. Oats; prairie or timothy hay.
2. Oats, 4parts; corn, 6 parts; bran, 3 parts; prairie or timothy hay.
3. Oats, 4 parts; corn, 6 parts; linseed meal, 1 part; prairie or timothy hay.
4. Corn, 7 parts; bran, 3 parts; linseed meal, 1 part; prairie or timothy hay.
5. Corn; alfalfa hay; prairie or timothy hay.

The above-mentioned parts are by weight. These combinations have proved satisfactory. Barley or kafir might be substituted for corn; bright, clean kafir hay or cane hay for prairie hay; clover hay, if bright, clean, and free from dust, for alfalfa.

A comparatively cheap and very satisfactory ration for a stallion in those parts of the country where alfalfa is plentiful is corn with alfalfa and prairie hay, about one-third alfalfa and two-thirds prairie hay. The alfalfa hay should be fed

Historical Document
Kansas Agricultural Experiment Station

in the morning, just a little prairie hay at noon, and the rest of the prairie hay at night, One-third of the corn should be fed at each meal, The alfalfa, being rich in protein, balances the corn nicely. Whatever the roughage may be, most of it should be fed at night, a small portion in the morning, and very little at noon.

The place where the stallion is kept should be flooded with sunlight, and properly ventilated. Sunlight and fresh air are antagonistic to the growth of disease germs, and are excellent tonics for a horse. There can not be too much fresh air; but beware of draughts. Arrange to have the stallion's stall in close proximity to the stalls of other horses, and see that this stall is always kept scrumputously clean.

The stallion should be carefully, thoroughly and regularly groomed. This stimulates the circulation and prevents troublesome skin diseases. The feet of many stallions are woefully neglected. They should be trimmed to about the normal size and shape, and, above all things, should be kept *level,* whether shod or not. If shoeing is necessary, insist that the shoe be made to fit the foot rather than the foot to fit the shoe, as is so often done. Do not allow the blacksmith to rasp off the wall of the foot after shoeing; he may think it makes the job "look better," but when he rasps the wall, he is helping to ruin the foot. Nature has put a thin coating over the outside of the wall of the hoof to prevent evaporation. This rasping also destroys the horn of the wall. The sole and frog of the foot should never be touched with a knife except to trim off spaingly the ragged edges. Do not allow the bars to be cut away. Nature intended that they should carry weight, so let them perform their natural function. Use as few nails as possible, and remember that high nailing is a ruinous practice.

Every stallion owner should aim to conserve the energies of his stallion as much as possible, and must not expect too much of a young horse. A big, strong two-year-old properly fed and handled should serve not more than fifteen mares the first season, and should serve at intervals of not less than five days; a three-year-old, not more than thirty-five mares at intervals of not less than two days; a four-year-old, not more than sixty mares and not more than one a day; and an aged horse should not serve more than two mares a day. Possibly the number of mares suggested may seem small to many; if so, this objection

Historical Document
Kansas Agricultural Experiment Station

may be overcome by using some method of artificial impregnation. This is a safe, sure and practical method of breeding, and several mares can thus be bred from one service.

Before a stallion is allowed to serve, the mare should be carefully examined; and if there are any suspicions she should be refused service. By allowing a stallion to serve a mare infected with any disease of the generative organs, this disease may be transmitted to all the rest of the mares bred to this horse unless the strictest precautions are taken. It is always well to have handy and use freely after service some mild but efficient disinfectant, such as a solution of one part of creolin to one hundred parts of water, or two parts of carbolic acid to one hundred parts of water. There are many other disinfectants, but these are efficient and safe.

No other animal is so intelligent or teachable as a well-bred stallion, and no animal will detect fear or wavering so quickly. The man who is afraid of a stallion has no business trying to handle one. Very few stallions are naturally bad-tempered or vicious, but many are made so by improper handling.

The Feed and Care of the Broodmare and the Foal.

One of the most important factors in profitable horse production is the quality of the brood mare. Usually too much has been expected of the sire. Success in this business demands good brood mares as well as good stallions.

Good brood mares are scarce and in great demand. Those who are fortunate enough to own them realize that these mares represent no small amount of invested capital. Such owners demand that each mare be a regular breeder.

It has been estimated that more than 40 per cent of the mares that are bred each year do not produce living colts. This means a tremendous loss. The fact that the greater portion of this loss may be prevented by proper care and management makes it highly important that the question be given more careful consideration and study.

The very first consideration in breeding is the selection of the stallion. A stallion should be selected that is a good, sound, representative type of his breed. One of the greatest impediments in improving the horses of the country has been the common but ruinous practice of mixing types and breeds.

Historical Document
Kansas Agricultural Experiment Station

Mares should be bred to the best individuals of the breed of which they are grades or pure-breds.

The question as to the age at which fillies should be bred often arises. If they are big, strong and vigorous they may be bred late in the season in which they become two years old, but if they are not particularly large and well developed for their ages it is best to wait until they are older. This latter suggestion would apply more particularly to medium-weight draft fillies, such as are usually found on the average farm. The sooner they are bred the more regular breeders they usually become, but they must not be bred too young, because of the danger of checking growth and development.

The mare that has foaled and cleaned properly should be bred on the ninth day, as experience has shown that the chance of "settling" at this time is greater than at any other time. She should be returned and tried in from eighteen to twenty-one days, and again at the end of another like period.

Some mare owners are still somewhat skeptical in regard to artificial impregnation, especially capsule breeding. This method is a practical, safe method of breeding, and in many instances is surer, when properly done, than the natural service. Success in this method of breeding depends upon absolute cleanliness and careful attention to details.

One should always strive to keep the brood mare in the best possible health; she should be well fed, protected from storms, kept free from disease, and handled carefully and gently at all times. Treating the brood mare harshly, causing her to become excited, often interferes with conception and may cause abortion. Kindness and gentleness cost very little, yet no other factors have a stronger influence for profit in horse production.

The young pregnant mare should be fed a ration containing a comparatively high per cent of bone-forming and muscle-forming feeds, for there is a demand from two sources for these kinds of feeds—her own immature body and the developing fœtus.

If the pregnant mare is suckling a foal, she must be fed not only to maintain her own body and develop a fœtus, but also to produce a plentiful supply of milk for the suckling foal. This means that she must be fed very liberally and that her feed must contain a rather high per cent of protein. The

Historical Document
Kansas Agricultural Experiment Station

following combination might be fed the brood mare that is worked :

1. Corn, 8 parts; bran, 1 part; alfalfa hay.
2. Oats; alfalfa hay.
3. Oats, 4 parts ; corn, *6* parts; bran, 4 parts; prairie or timothy hay.
4. Corn, 6 parts; bran, 3 parts; alfalfa hay, one-third; prairie hay, two-thirds.
5. Corn, 6 parts; bran, 3 parts; linseed meal, 1 part; prairie hay or timothy hay.

The amount to be fed depends upon the size of the mare and the severity of the work done. If it is not necessary to work the brood mare, the best place for her is in a good pasture. If the pasture is poor she ought to be fed some grain, oats or a combination of corn and bran being preferred.

The brood mare may be worked regularly, but, of course, must not be expected to do as much work as a gelding or a mule. Care should be taken to avoid making pregnant mares pull too hard; they must not be asked to back heavy loads. Severe strain must be avoided, as it might cause abortion. As foaling time approaches the work should be lightened, so that toward the latter part of the period of pregnancy she will be getting only enough work to keep her in good physical condition. It is a good plan to quit working the brood mare a week before foaling, but after laying her off do not allow her to stand in the stall without exercise. If a pasture or a paddock is available, she should be turned into this, care being taken not to expose her to stormy weather.

The best place for a mare to foal is in a pasture, if the weather will permit; otherwise a roomy box stall that is kept clean should he provided, thoroughly disinfected and liberally bedded with bright, clean straw. As the time approaches for the mare to foal, she should be carefully watched but not bothered. One should be on hand to render assistance if such assistance becomes necessary. Give the mare half a bucket of water after foaling and another half bucket in a few hours. Do not hasten to give her a heavy feed of grain. A light feed of bran will do for the first feed after foaling; this to be followed by oats, if available. If oats are not available, corn and bran, in equal parts by bulk, may be substituted.

A great many foals die of navel infection, or joint disease,

Historical Document
Kansas Agricultural Experiment Station

as it is called. This disease is caused by germs which are found in dirty or unsanitary quarters. If the mare foals in a pasture or in a box stall that has been kept scrupulously clean and thoroughly disinfected, very little trouble is likely to result from navel infection, or joint disease. Prevention is the best and surest treatment; hence it is well in any case to wash the cord, as soon after the foaling as possible, with a solution of one part of creolin, or some other coal-tar disinfectant, to one hundred parts of water, or five parts of carbolic acid to one hundred parts of water. Then squeeze out and tie off the navel cord one or two inches from the body with a string that has been soaked in iodine; paint the cord with tincture of iodine. It would be a good plan to apply tincture of iodine every few hours during the first day. Sometimes an astringent powder is applied every few hours after tying off, until the cord becomes dried up.

If the mare is worked, the colt should be left in a cool, dark stall during the day. For the first few weeks the mare should be brought to the barn and the colt allowed to suckle in the middle of the forenoon and the middle of the afternoon, as well as at morning, noon and evening. The colt should be left with the mare at night. Encourage the colt to eat as soon as possible, preferably crushed oats with bran. If oats are not available, the following ration may be substituted: crushed corn, four parts; bran, three parts; linseed meal, one part; these proportions being by weight. Let the colt have alfalfa or clover hay as soon as he will eat it. See that he has access to clean, pure water at all times, if possible.

If the mare and the foal are running in the pasture, a "creep" should be made where the colt can have access to grain. To raise high-class horses one must feed them liberally and keep them continually growing and developing from the very first. It is poor economy to skimp on the colt's feed. The stunted colt never fully recovers. The feed and the care a colt gets during the first year and a half of its life determine largely what that colt will be at maturity.

Historical Document
Kansas Agricultural Experiment Station

THE FEED AND CARE OF THE ORPHAN FOAL.

It often becomes necessary to raise a foal by hand, whereupon the question arises as to the feeding of such a foal so as to secure the best results. It is a tedious task requiring a great deal of patience, careful attention to details, and absolute cleanliness of all utensils used in feeding.

Cow's milk must be the basis of the ration to be fed; the poorer this milk is in butter fat, the better suited it is as a food for an orphan foal, because an excessive richness in butter fat causes scouring and other digestive disorders. As some differences exist in the composition of cow's milk and mare's milk, the cow's milk must be changed so as to be as nearly equivalent in composition to mare's milk as possible. Henry gives the average composition of mare's milk and cow's milk as follows:

	No. of analyses.	Water.	Casein and albumen.	Fat.	Sugar.	Ash.
Mare's milk	72	90.58%	2.05%	1.14%	5.87%	.36%
Cow's milk	705	87.27	3.39	3.68	4.94	.72

This shows that mare's milk contains more water, but only about half as much casein, albumen and ash as cow's milk, while the sugar is nearly one per cent higher. Average cow's milk contains over three times as much fat as average mare's milk. Hence, it would seem necessary to add water and sugar to cow's milk when it is to be fed to orphan foals, and practical experience corroborates this theoretical deduction.

The first milk of the dam acts as a mild laxative to remove the faeces from the bowels of the new-born colt. If the orphan foal does not receive this first milk, it should be given a dose of from one and one-half to two ounces of castor oil in fresh cow's milk.

The following method of preparing and feeding cow's milk to orphan foals has proved satisfactory: To a tablespoonful of sugar, preferably white sugar, add enough warm water to dissolve it, then add from three to five tablespoonfuls of lime water and enough fresh milk to make a pint. Feed about one-fourth of this mixture every hour for the first few days, always being sure that it is at body temperature at the time of feeding. If these precautions are not taken digestive disturbances occur very readily in hand-fed colts. The lime water

Historical Document
Kansas Agricultural Experiment Station

helps to correct digestive disorders and to keep the digestive organs in a healthy condition.

Various methods for getting the colt to take the milk have been suggested. Probably as cheap and at the same time as satisfactory a method as any is to use a bottle and nipple. All pans, buckets or bottles used in feeding the colt should be thoroughly cleansed and scalded after using, and all milk fed to the orphan foal must be fresh and clean and must always be fed warm; that is, at body temperature. Many colts have been killed simply by neglect of these important details. As the colt grows older, the intervals between feeding times are lengthened and the amount fed each time is increased. The condition of the colt should be the guide as to the amount fed. If it scours, cut down on the amount of milk and give from two to four ounces of the following mixture: castor oil, two parts; sweet oil, one part. When the colt becomes three or four weeks old the sugar may be discontinued, but it is well to continue the use of lime water. The colt may be given all the sweet, skimmed milk it will drink three times daily after reaching the age of three months.

The colt should be taught to eat grain and alfalfa or clover at the earliest possible age. Crushed oats with a little bran are the best grain to feed, but are not always available. A fairly good substitute is crushed corn and bran, in equal parts by bulk, to which a small amount of linseed meal may be added. As soon as possible allow the colt access to grass in addition to the feeds mentioned. Feed the orphan liberally, keep it in a thrifty, healthy condition, and there is no reason why it should not develop into practically as good a horse as it would have done had it been nursed by the mother.

THE FEED AND CARE OF THE GROWING HORSE.

In feeding and caring for the growing horse, the aim and purpose should be to do this in such a manner that the greatest possible physical development may be secured, and that the growing horse may mature into a strong, healthy, vigorous animal. Often it is fed too sparingly, with the hope that the growth which it does not make as a colt will be made at some later time. This is a mistaken idea, for the stunted colt will

Historical Document
Kansas Agricultural Experiment Station

never fully recover. In developing and feeding young, growing horses one should rememher that the feed and care they receive during the first year or year and a half of their lives determine largely what they will be a maturity. The young, growing horse must be fed liberally the proper kinds of feed.

The development of the bony framework and the protein tissues, such as muscles, tendons, ligaments, viscera and the nervous system, must not be checked in the growing animal. The mineral content of the ration, as well as the protein, the carbohydrates and the fat, must be carefully considered. The bony framework demands a considerable amount of calcium and phosphorus ; the nervous tissues demand phosphorus ; the blood demands sodium, potassium and iron. These, together with sulphur and magnesia, are the most important forms of inorganic matter needed.

Experience has shown that colts make a better growth on a ration of corn and alfalfa hay than on corn and timothy or prairie hay. This difference is probably due as much to the difference in mineral content of the two rations as it is to the difference in the digestible nutrients contained in each. A comparison of the mineral content of a combination of one pound of corn and one pound of alfalfa hay, and a combination of one pound of corn and one pound of timothy hay, is shown in the following table.

	Lime, lbs.	Phosphoric acid, lbs.	Iron oxide, lbs.	Soda, lbs.	Potash, lbs.
Corn ..... 1 lb. } Alfalfa hay... 1 lb. {	.0134	.0132	.00208	.0021	.0236
Corn ..... 1 lb. } Timothy hay.. 1 lb. {	.0033	.0104	.00048	.001	.0199

This table shows that a combination of one pound of corn and one pound of alfalfa hay contains about eleven and one-half times as much lime, the principal constituent of the bony framework, as a combination of one pound of corn and one pound of timothy hay.

It so happens that most of the feeds that contain large amounts of mineral matter — alfalfa hay, bran, and linseed meal — also contain large amounts of digestible protein, the muscle-forming element, so it is evident that these feeds should enter largely into a ration to be fed the young, growing horse during that part of the year when grass is not available. With the bran, linseed meal and alfalfa hay there must be combined

Historical Document
Kansas Agricultural Experiment Station

oats, corn, barley, kafir, milo, or speltz. Of these, oats is the most desirable, but is usually very high in price; and almost as good results may be secured by using corn, kafir, barley, or speltz, if properly balanced with alfalfa, bran, or linseed meal. Cowpea hay or clover hay may be substituted for alfalfa hay. The combination of feeds to be used depends somewhat upon the feeds available and their cost in the particular locality. However, the best results in developing young, growing horses will come only from those combinations which are rich in mineral matter and protein.

The following combinations have proved satisfactory:

1. Corn or oats, 6 parts; bran, 2 parts; linseed meal, 1 part; free access to alfalfa hay, together with some prairie hay, straw, or corn fodder.

2. Corn or oats, 6 parts; bran, 3 parts; free access to alfalfa hay, together with some prairie hay, straw, or corn fodder.

3. Corn or oats; alfalfa hay.

Linseed meal, while not absolutely necessary when bran and alfalfa hay are used, gives the coat a glossy appearance, indicating thrift and good condition, and also seems to stimulate and assist digestion and assimilation. Horses will relish a little prairie hay, straw or corn fodder when fed large amounts of alfalfa hay.

So far the discussion has been entirely upon the subject of winter feeding. During the summer the cheapest, and probably the best, ration for the growing horse is pasture grass of some kind. In Kansas this pasture will, in most cases, be blue grass, bluestem, buffalo grass, brome grass, alfalfa, or a combination of one or more of these grasses. If the pasture is good, very little, if any, grain will be necessary for *average* growth; but if the pasture is poor, if the season is dry, or if the colts do not continue to grow and remain thrifty and in good condition, it will be necessary to feed some grain, especially to the sucklings and the yearlings. If the *maximum* of growth and development is desired it will be necessary, until the horse reaches maturity, to feed some grain with any kind of pasture. The grain portions of the rations suggested above are well suited to this purpose. Horses should have access to salt at all times.

Another important matter in developing growing animals is

Historical Document
Kansas Agricultural Experiment Station

the water supply. Often a water shortage for a few days, or even weeks, does not cause much concern or alarm, and a plentiful supply of stagnant or even filthy water is often deemed sufficient; but either condition is a serious detriment to the growth and thrift of the young animal. It is just as necessary that growing animals have a plentiful supply of clean, pure water as it is that they be well fed. This is particularly true during the summer.

At three years of age the growing horse should be able to do considerable work. From that time to the full maturity of the animal the protein feeds should be gradually decreased and the energy-producing feeds gradually increased, until the protein and energy-producing requirements of a mature work horse are reached.

Aside from feeding, probably the most important consideration in developing growing horses is the care of the feet. The old saying, "No foot, no horse," is just as true and applicable to-day as it ever was, and too much emphasis can not be placed upon the proper care of the feet of the colt and the young horse. Many of the poor feet seen in horses are the result of neglect of the feet while these horses were young. The toes should not be allowed to grow abnormally long and ill shaped, as serious trouble may result from cracking or breaking of the hoof. Neither should the heels be allowed to become high, narrow, or rolled. If these ill shapes are not corrected, the feet, and to some extent the legs, respond to these influences, and the horse matures with poorly shaped feet and often poorly set legs. Beware of thrush and kindred troubles. If the stables are kept clean and sanitary there will be very little trouble from this source. Careful attention to these details will help greatly in developing big, well-shaped, strong, healthy feet.

Ordinarily the growing horse will do very well in winter, under our average climatic conditions, with an open shed for protection from wind and storm. If barn room is available, however, it will pay to put the horses in at night, but their quarters must be well lighted, well ventilated, and sanitary. During the summer season when the horses are on pasture, if there are no trees for protection from sun and storms, an open shed will be profitable.

Historical Document
Kansas Agricultural Experiment Station

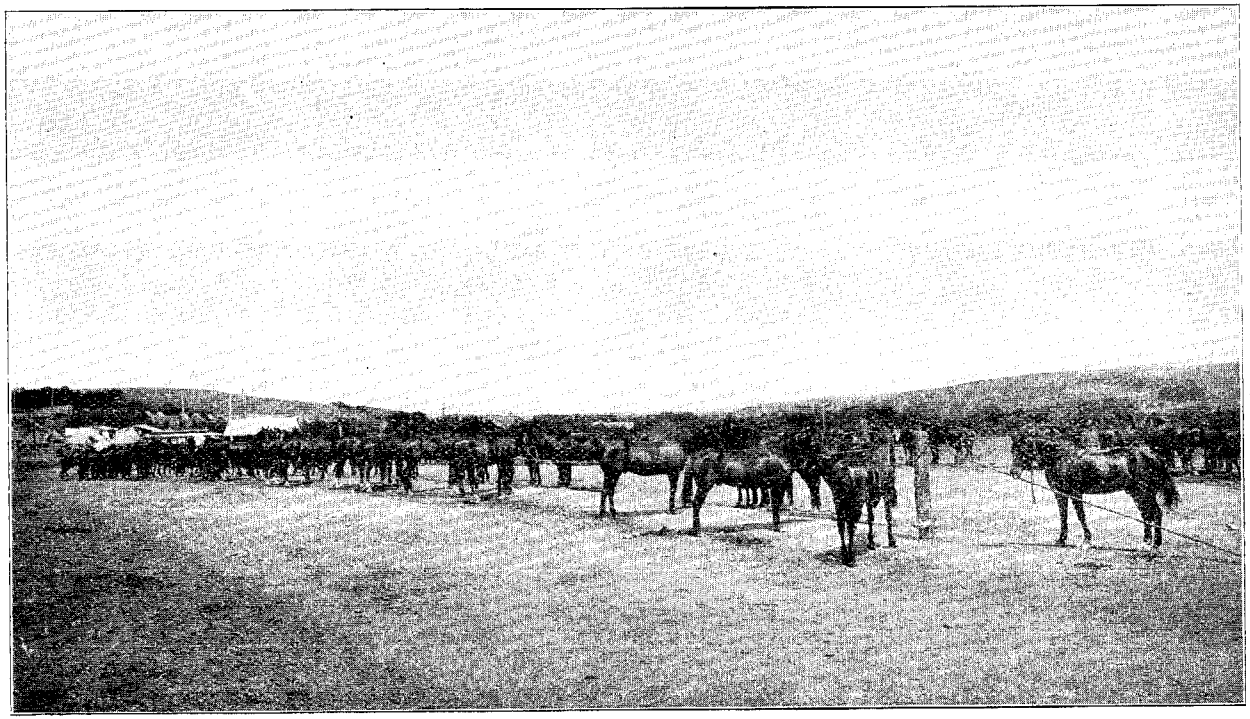


PLATE I.—Artillery horses on a picket line. Lots 7 and 8.

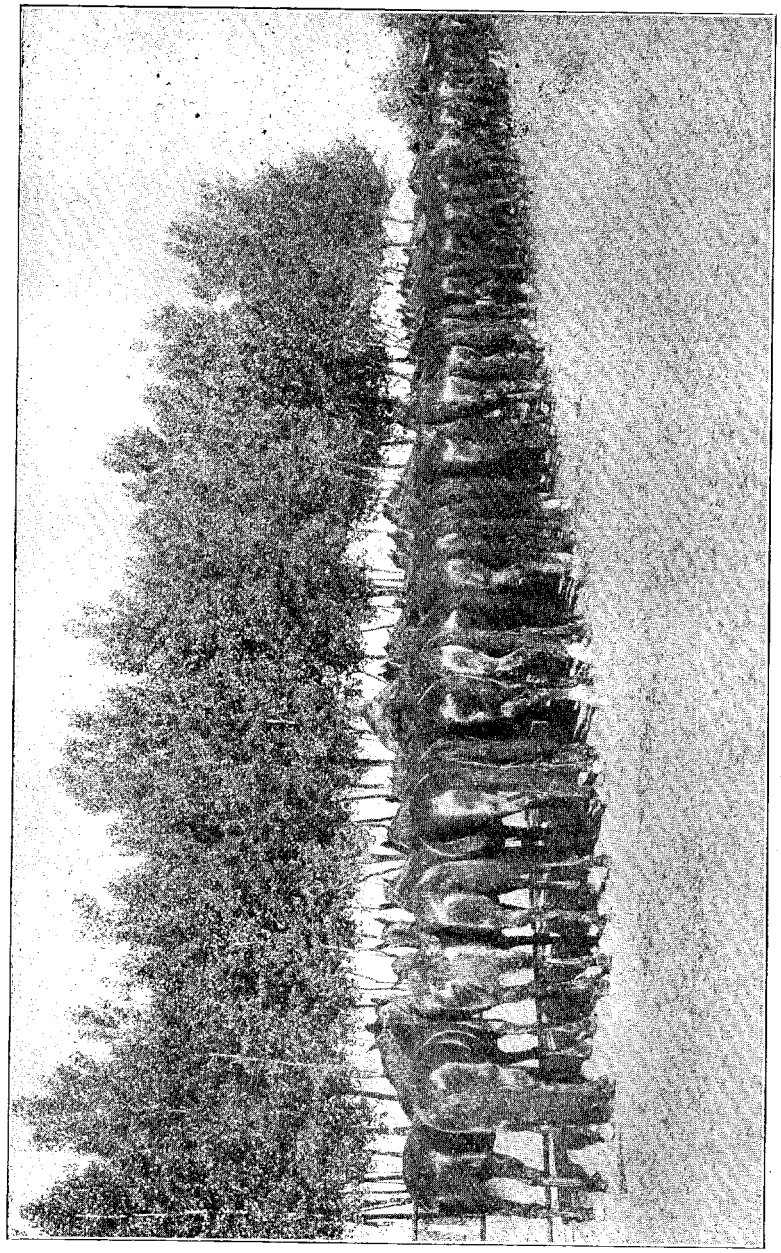


PLATE II.—Lot 1 at the end of 140 days feeding.
Ration.—Oats 10.51 lbs., prairie hay 12.25 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

Historical Document
Kansas Agricultural Experiment Station

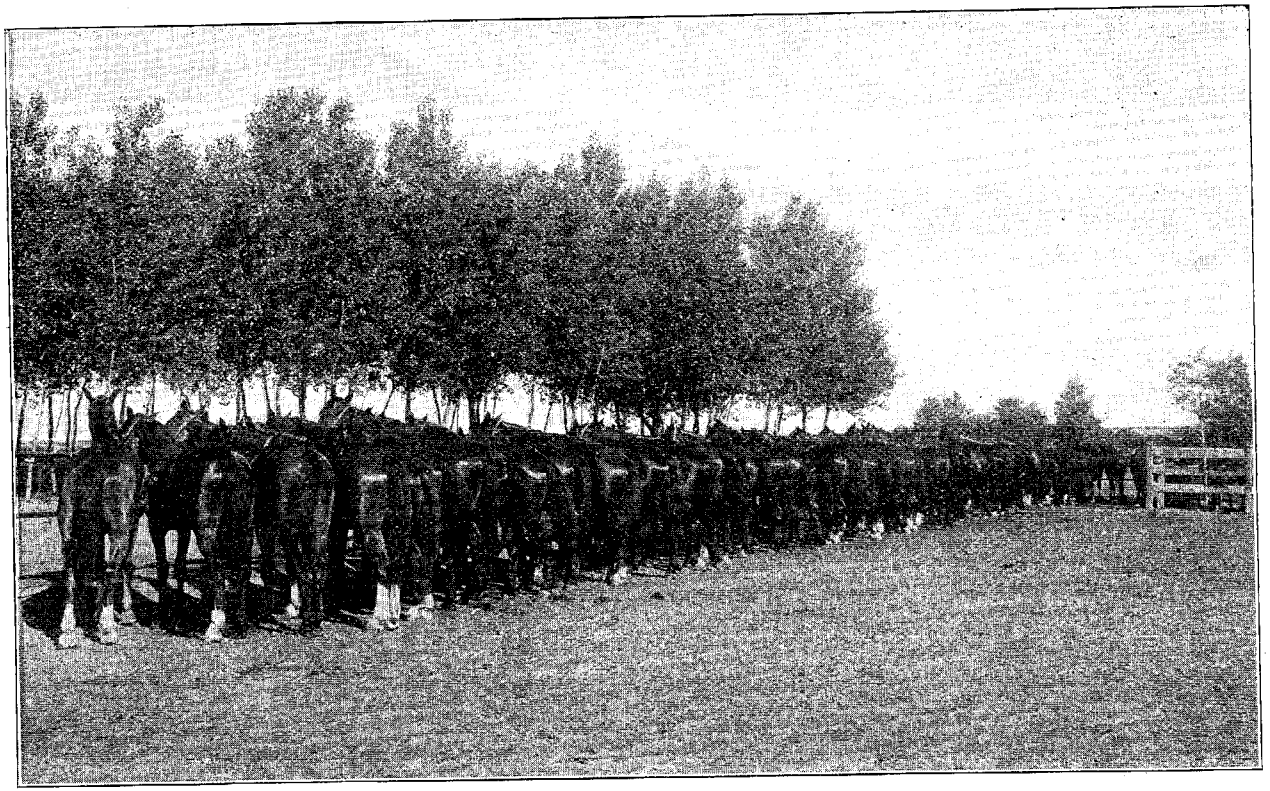


PLATE III.—Lot 2 at end of 140 days feeding.

Ration.—Corn 10.27 lbs. and prairie hay 11.98 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

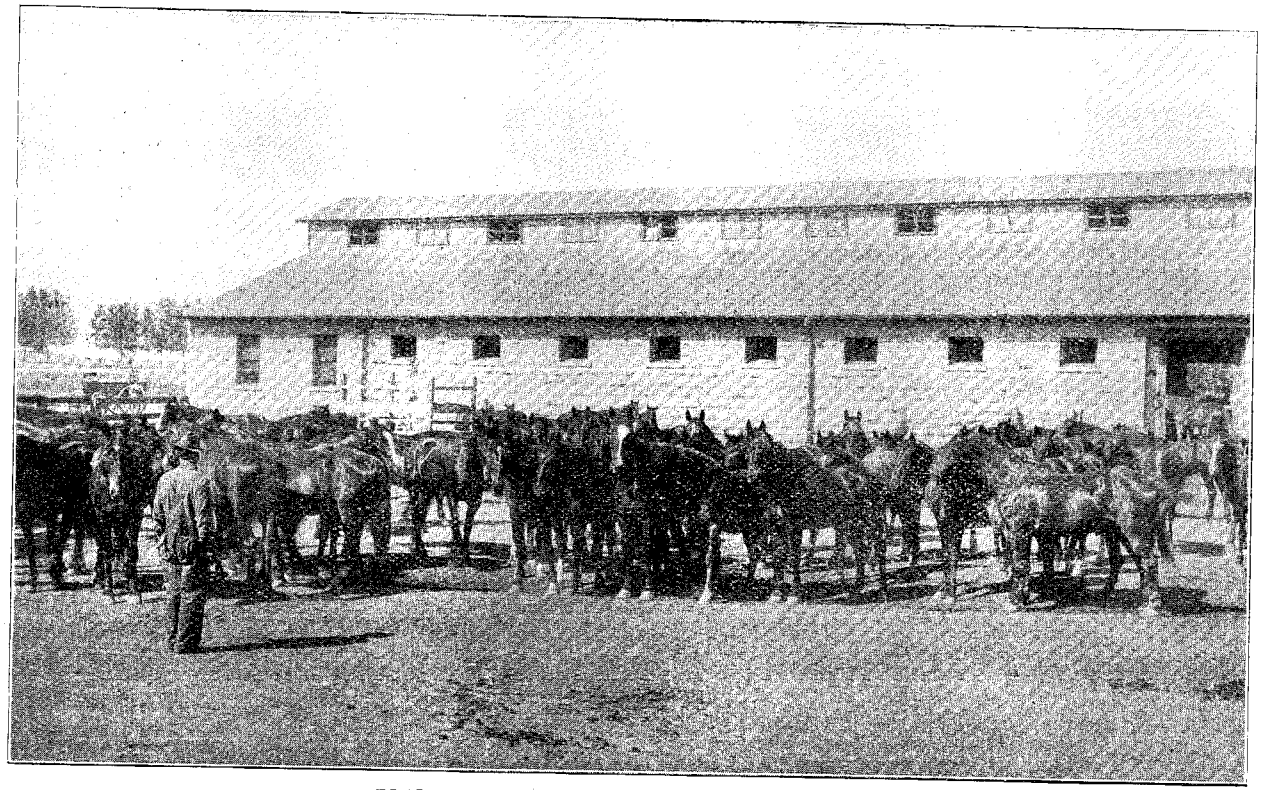


PLATE IV.—Lots 3 and 4 at end of 140 days feeding.

Ration.—Lot 3—Oats 6.78 lbs., corn 3.39 lbs., and prairie hay 11.86 lbs. a day per 1000 pounds live weight.

Ration.—Lot 4—Oats 6.90 lbs., corn 3.45 lbs., timothy hay 12.08 lbs. a day per 1000 pounds live weight.

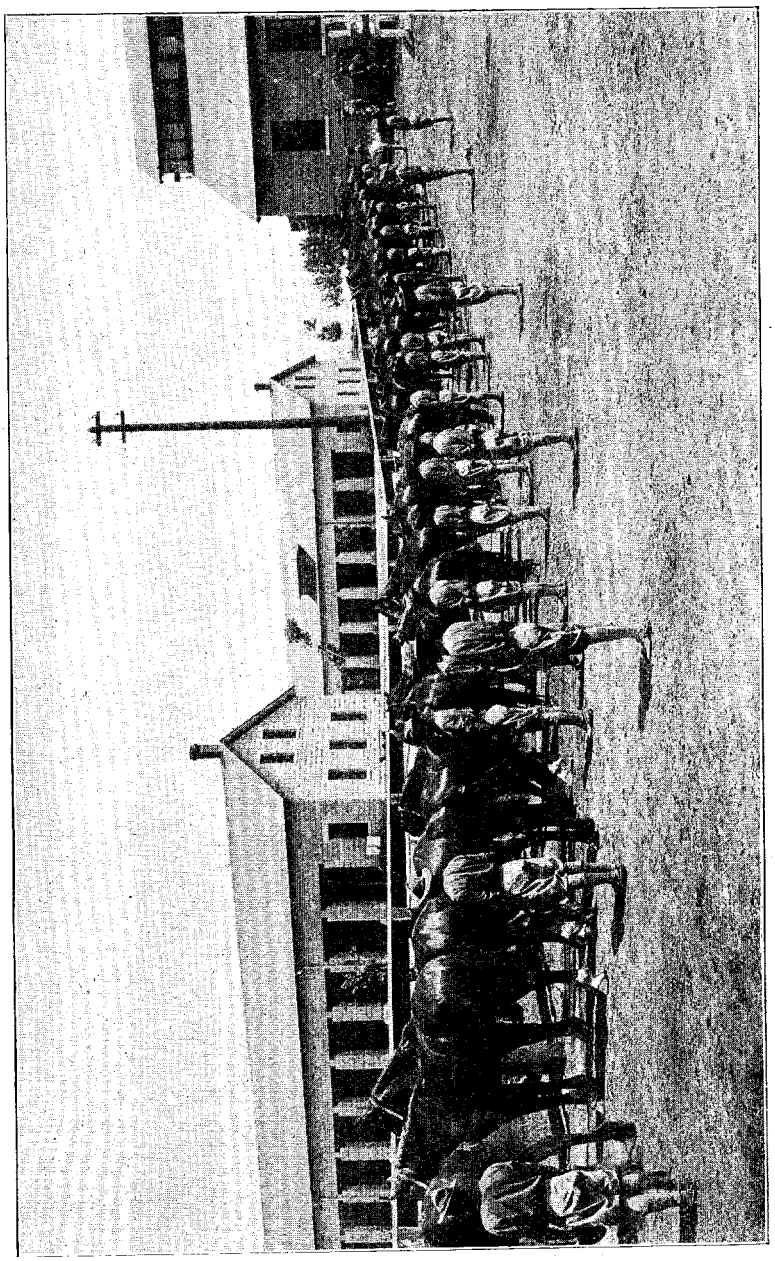


PLATE V.—A group of horses from lots 5 and 6.

Historical Document
Kansas Agricultural Experiment Station

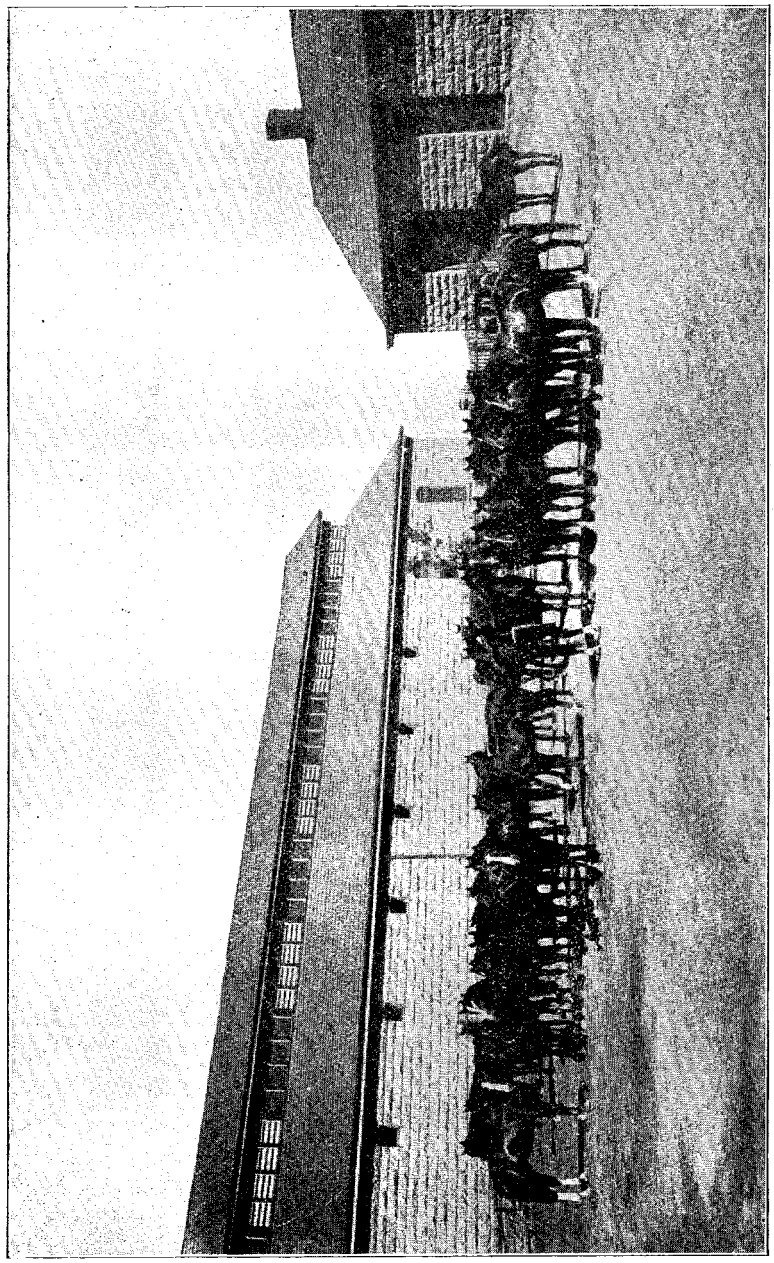


PLATE VI.—Lot 9 at the end of 110 days feeding.

Ration.—Oats 3.39 lbs., corn 5.09 lbs., bran 3.39 lbs., timothy hay 10.17 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

Historical Document
Kansas Agricultural Experiment Station

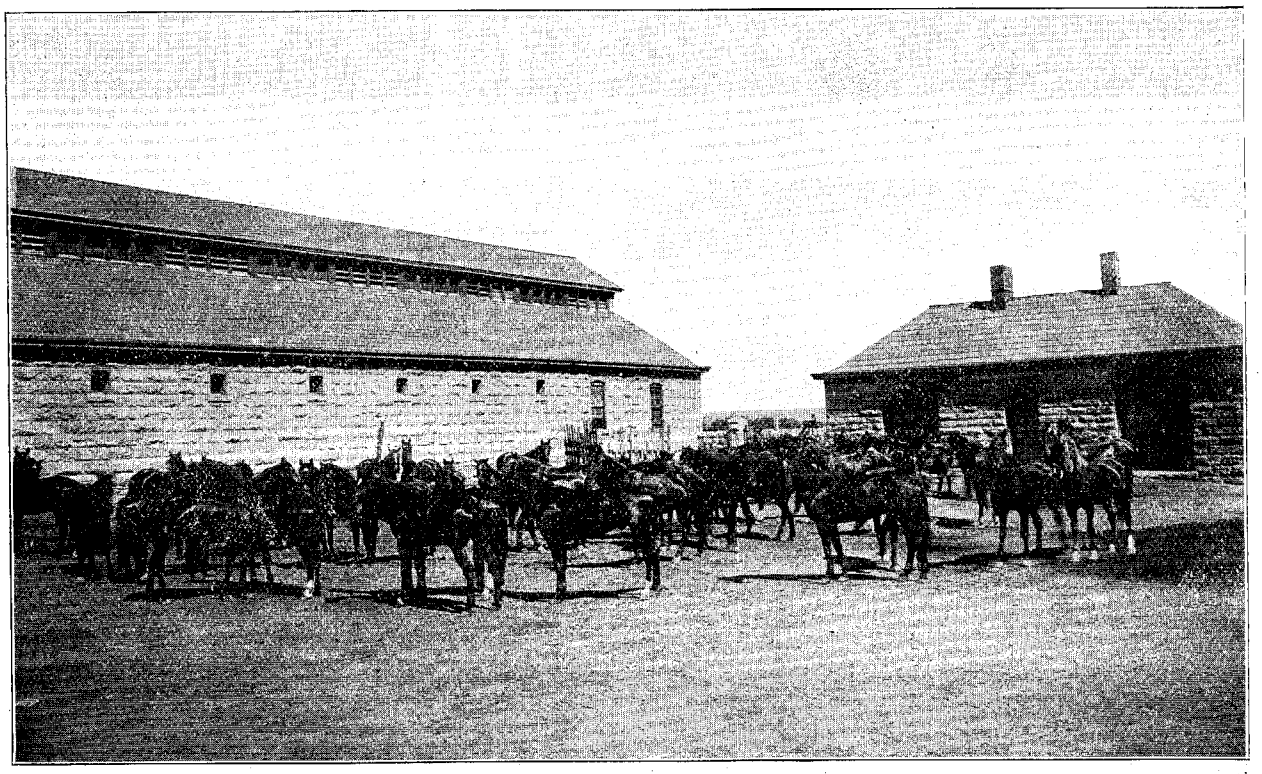


PLATE VII.—Lot 10 at the end of 110 days feeding.

Ration.—Oats 3.41 lbs., corn 5.11 lbs., linseed meal .85 lb., and prairie hay 10.23 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

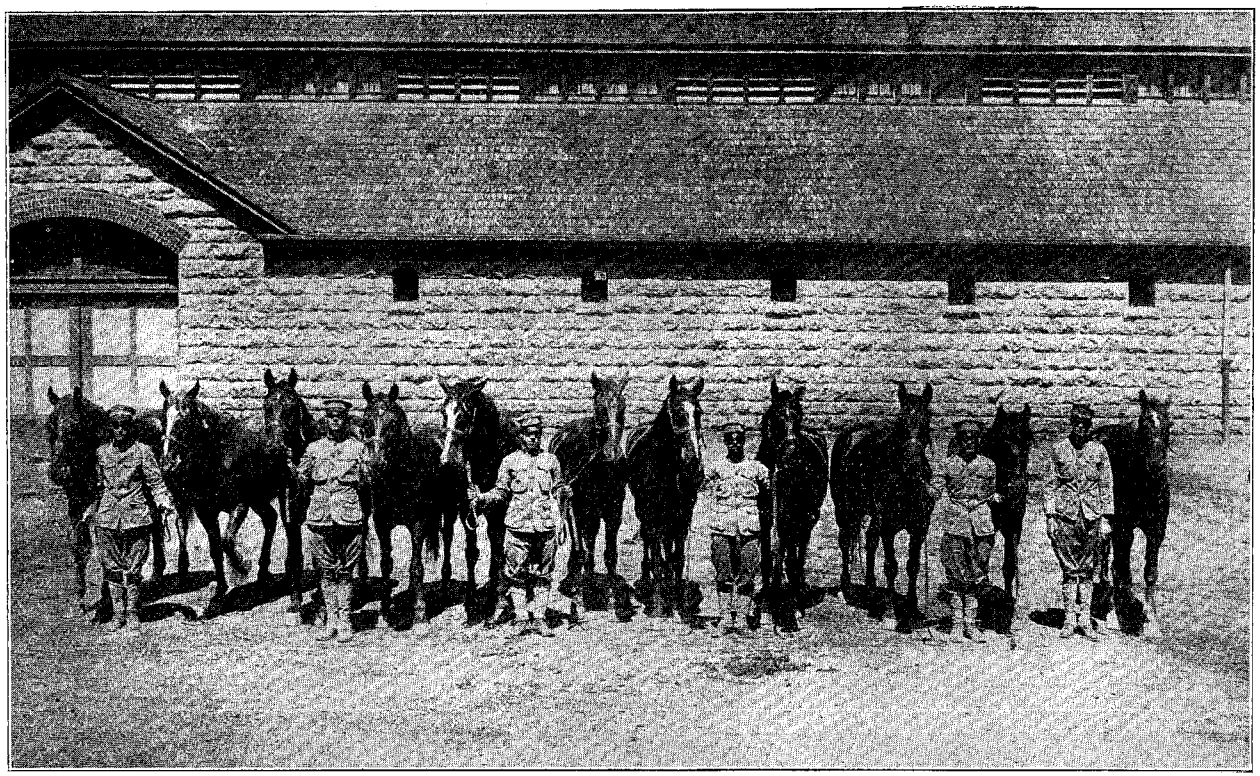


PLATE VIII.—Lot 11—Front view at end of 140 days feeding.
Ration.—Oats 10.26 lbs., prairie hay 11.98 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

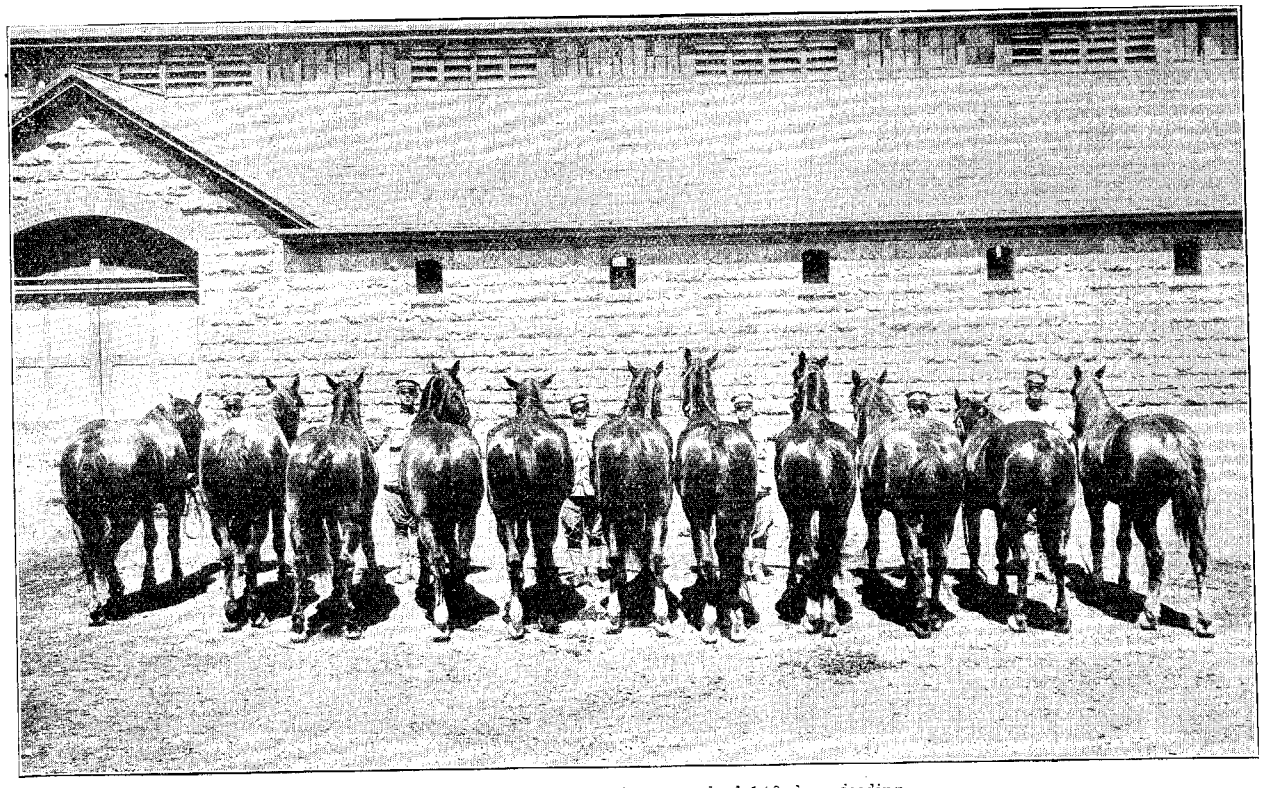


PLATE IX.—Lot 11—Rear view at end of 140 days feeding.

Ration.—Oats 10.26 lbs., prairie hay 11.98 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

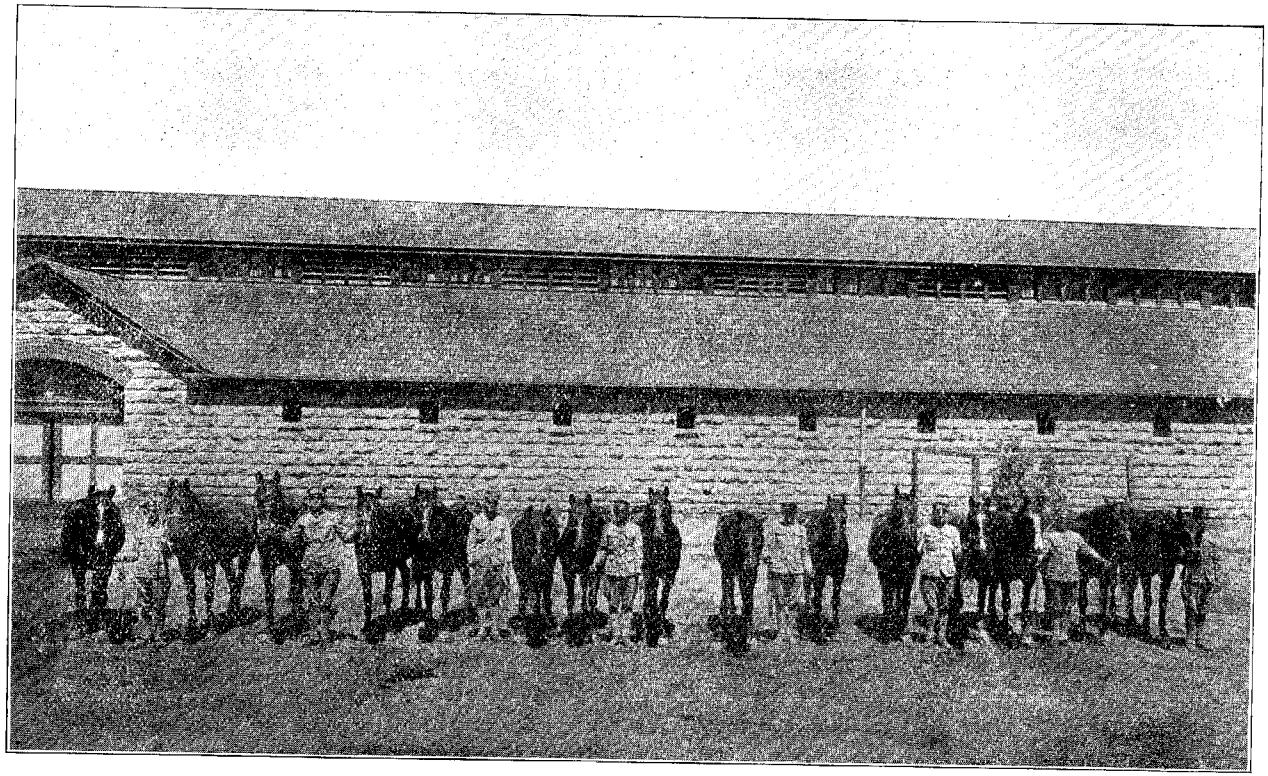


PLATE X.—Lot 12—Front view at the end of 140 days feeding.

Ration.—Corn 6.8 lbs., oats 1.7 lbs. and alfalfa hay 8.5 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station

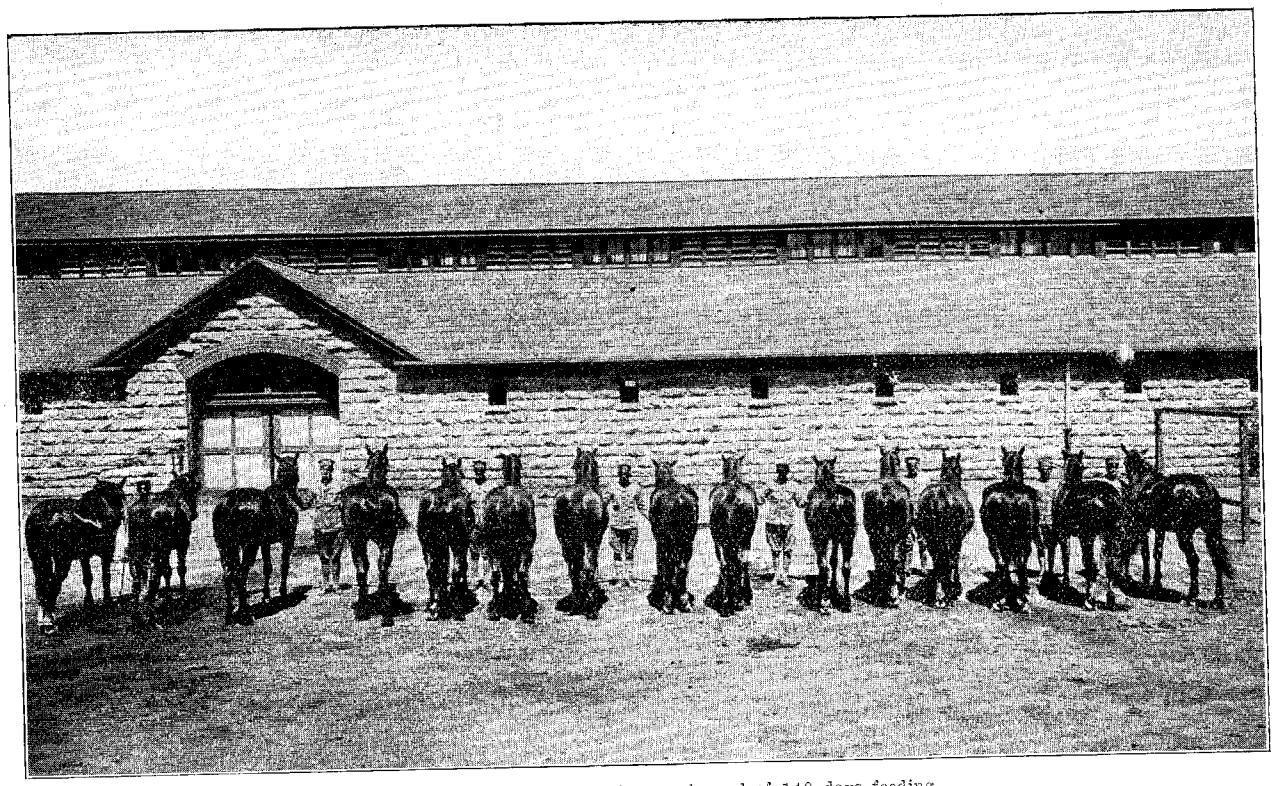


PLATE XI.—Lot 12—Rear view at the end of 140 days feeding.

Ration.—Corn 6.8 lbs., oats 1.7 lbs. and alfalfa hay 8.5 lbs. a day per 1000 pounds live weight.

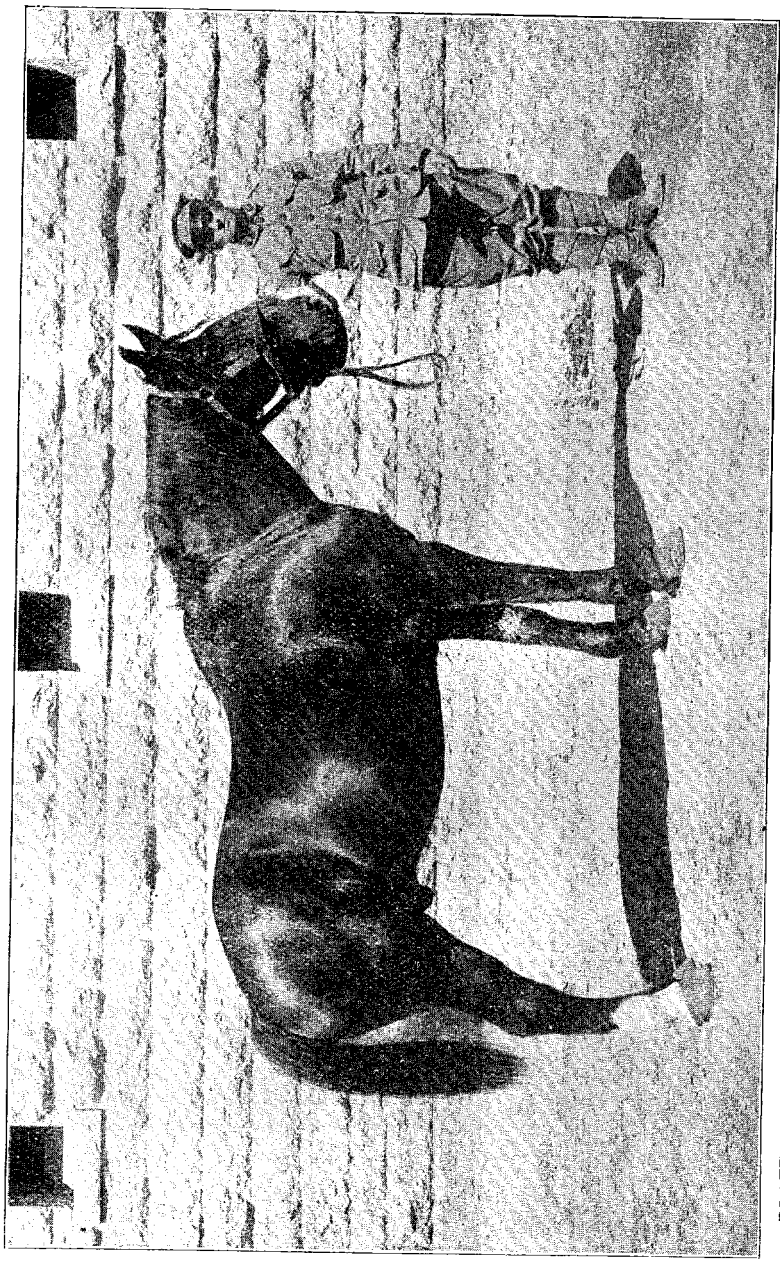


PLATE XII.—Duke, 1300-pound horse at end of 140 days feeding on 8 lbs. shelled corn, 2 lbs. oats, 10 lbs. alfalfa hay per day.

Historical Document
Kansas Agricultural Experiment Station

Historical Document
Kansas Agricultural Experiment Station

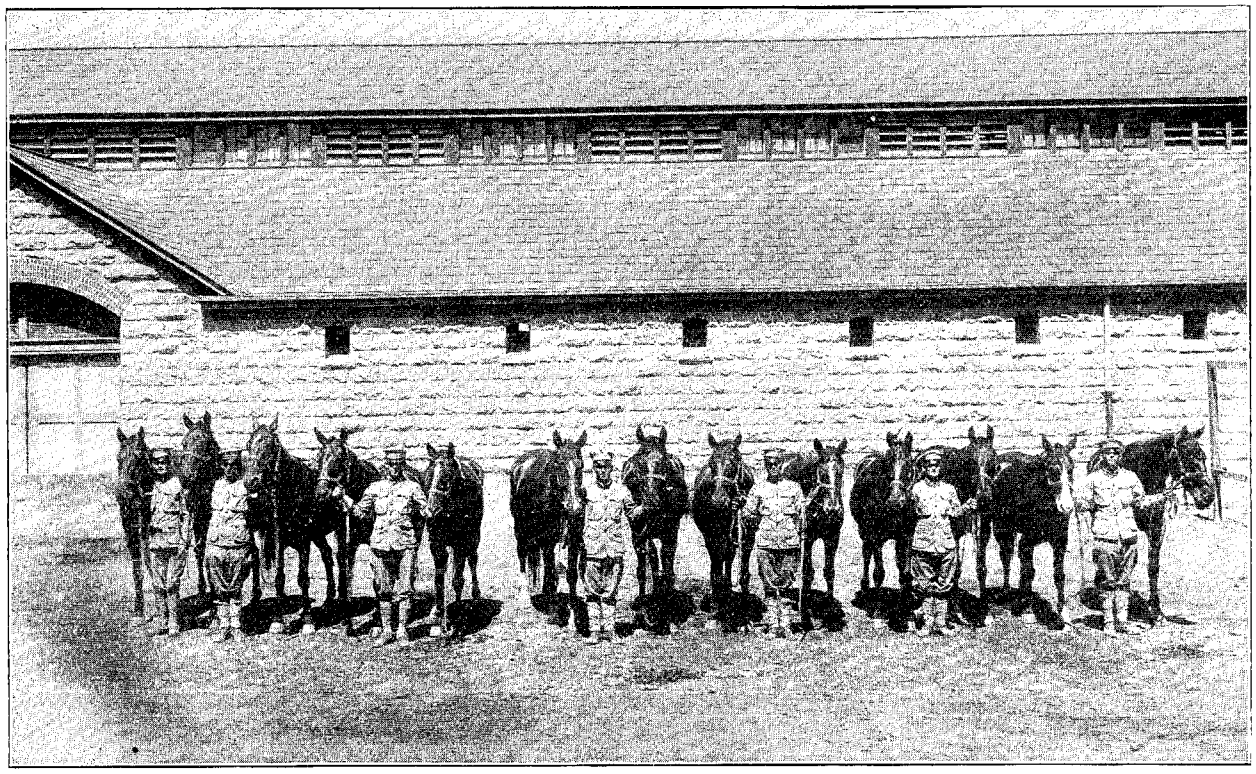


PLATE XIII.—Lot 15—Front view at the end of 140 days feeding.

Ration.—Shelled corn 5.16 lbs., bran 2.58 lbs., linseed meal .86 lb. and prairie hay 12.95 lbs. a day per 1000 pounds live weight.

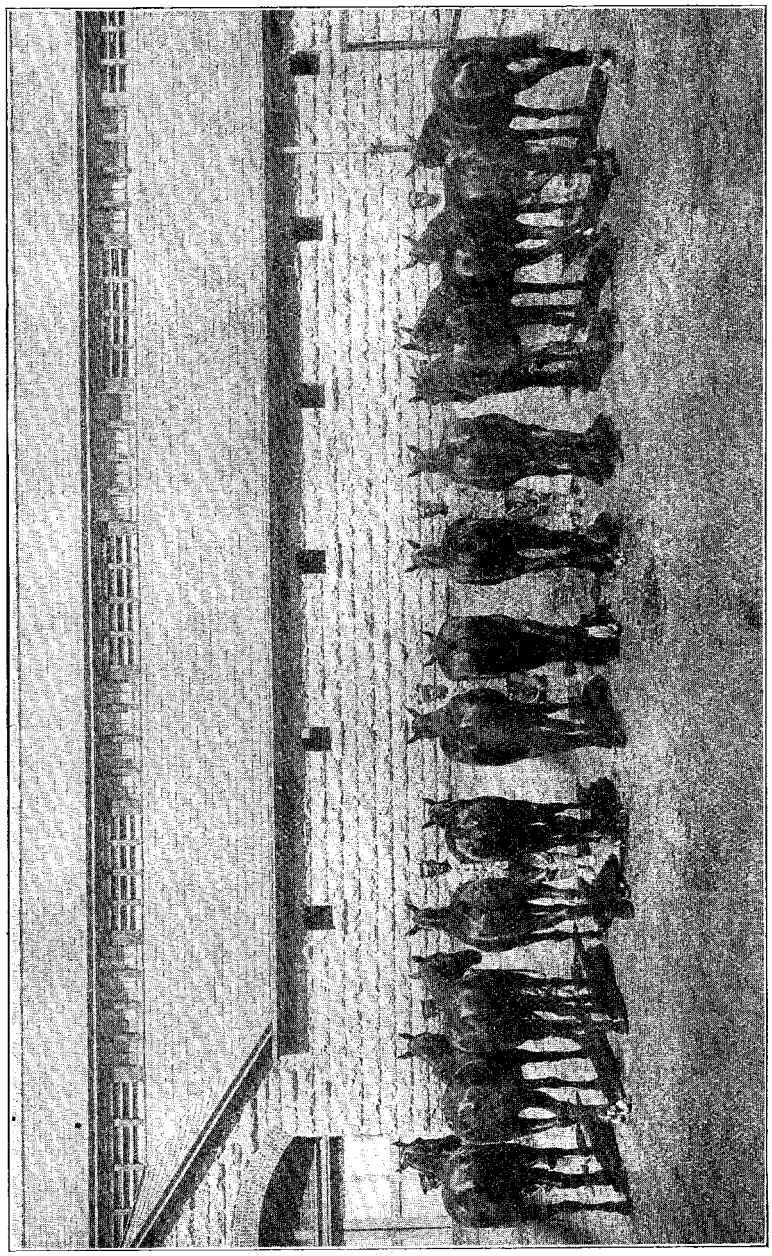


PLATE XIV.—Lot 15—Rear view at the end of 140 days feeding.

Ration.—Shelled corn, 5.16 lbs., bran 2.58 lbs., linseed meal .86 lb. and prairie hay 12.05 lbs. a day per 1000 pounds live weight.

Historical Document
Kansas Agricultural Experiment Station