

ALFALFA IN THE HOG RATION

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## INTRODUCTION

Alfalfa, which means "best fodder" in Arabic, has proved to be just that when fed to the various classes of livestock. The earliest use of alfalfa as a feed for hogs is not known, however it is thought that alfalfa pasture has been used as a supplemental feed since its introduction in this country. The earlier work of the experiment stations attempted to substitute alfalfa hay or meal for a large part of the grain ration. The advance of the science of nutrition proved that hogs cannot economically digest large quantities of roughage as ruminant animals do, and there was no advantage in feeding alfalfa in large quantities to fattening hogs.

It is known that the cereal grains, such as oats, wheat, barley and white corn are deficient in vitamin A. Yellow corn contains sufficient carotene to prevent the more serious forms of a vitamin A deficiency such as "night blindness." Alfalfa hay of good quality is known to be a very good source of vitamin A and would correct the carotene deficiencies of the cereals, which should result in increased growth of pigs.

Alfalfa, although usually not fed for that purpose in a hog ration, is a very good source of calcium.

Rations usually fed Oklahoma hogs are composed of one of the cereal grains, tankage and cottonseed meal. A ration such as this has been shown to be deficient in a growth factor or vitamin A.

The purpose of this experiment is to determine the possibilities of using alfalfa meal as a home grown carotene supplement to the hog rations commonly used in Oklahoma.

## REVIEW OF LITERATURE

## Alfalfa as a Protein Supplement

Cottrel (5), in a sixty-three day experiment with 125 pound pigs compared alfalfa hay and meal with soybean meal as a single supplement to kafir corn. The following rations were self fed free choice.

Lot I, kafir meal and alfalfa hay.

Lot II, kafir meal and alfalfa meal.

Lot III, kafir meal four parts and soybean meal one part.

Lot IV, kafir meal.

Lot I made an average daily gain of 1.44 pounds, and required 587 pounds of feed for each 100 pounds of gain. Lot II made an average daily gain of 1.32 pounds and required 616 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of 1.55 pounds and required 468 pounds of feed for each 100 pounds of gain. Lot IV made an average daily gain of .83 pounds, and required 468 pounds of feed for each 100 pounds of gain. In this trial the grain requirement for 100 pounds of gain was increased when alfalfa hay was ground and fed in the meal form. The most satisfactory finish was in Lot III, fed the soybean meal.

McCann and Tomhave (18) report a seventy-four day trial to compare various protein supplements when fed with corn. The average initial weight of the pigs was 109 pounds. The following rations were self fed:

Lot I, corn meal 10 parts and tankage 1 part.

Lot II, corn meal 7 parts and linseed meal 1 part.

Lot III, corn meal 2 parts, and chopped alfalfa hay 1 part.

Lot I made an average daily gain of 1.19 pounds, and required 505 pounds of feed for each 100 pounds of gain. Lot II made an average daily gain of .51 pounds and required 895 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of .31 pounds and required 1,320 pounds of corn and alfalfa hay for each 100 pounds of gain.

Carlyle and Morton (3) in a ninety-one day experiment compared alfalfa hay with tankage as a single supplement to corn or barley for fattening hogs with an initial weight of 68 pounds.

Lot I fed a ration composed of corn and alfalfa meal made an average daily gain of 1.17 pounds, and required 563 pounds of feed for each 100 pounds of gain. Lot II fed a ration of corn and alfalfa hay, made an average daily gain of 1.26 and required 584 pounds of feed for each 100 pounds of gain. Lot III fed corn and barley equal parts, plus alfalfa hay made an average daily gain of 1.26 pounds and required 502 pounds of feed for each 100 pounds of gain. Lot IV fed corn 9 parts and tankage 1 part, made an average daily gain of 1.56 pounds, and required 428 pounds of feed for each 100 pounds of gain. Lot V fed barley 9 parts and tankage 1 part made an average daily gain of 1.47 pounds and required 4.51 pounds of feed for each 100 pounds of gain.

Kinzer, Waters and Wheeler (14) compared alfalfa hay with varying proportions of tankage when fed as a single supplement to cornmeal. In this trial 135 pound hogs were self fed for sixty-five days. Lot I fed corn meal and alfalfa hay in racks made an average daily gain of 1.18 pounds, and required 631 pounds of feed for each 100 pounds of gain. Lot II fed corn meal 92 per cent and tankage 8 per cent made an average



daily gain of 165 pounds, and required 455 pounds of feed for 100 pounds of gain. Lot III fed corn 85 per cent and tankage 15 per cent, made an average daily gain of 1.50 pounds, and required 463 pounds of feed for 100 pounds of gain.

Barnett and Goodell (2) report a comparison of alfalfa meal to other protein supplements. Four lots of five pigs each were used in this eighty-four day trial. The rations were self-fed free choice. Lot I fed corn and alfalfa meal, made an average daily gain of 1.46 pounds, and required 473 pounds of feed for each 100 pounds of gain. Lot II fed corn and soybeans made an average daily gain of 1.62 pounds and required 453 pounds of feed for each 100 pounds of gain. Lot III fed corn and peanut meal made an average daily gain of 1.62 pounds, and required 431 pounds of feed for each 100 pounds of gain. Lot IV fed corn and tankage made an average daily gain of 1.77 pounds, and required 413 pounds of feed for each 100 pounds of gain.

In a 118 day trial, Vinke and Bergstedt (35) fed two lots composed of twenty pigs each to compare tankage and alfalfa hay as single supplement to a grain mixture. Lot I receiving a ration composed of equal parts barley and winter rye plus alfalfa hay made an average daily gain of 1.23 pounds and required 487 pounds of feed for each 100 pounds of gain. Lot II fed equal parts barley and winter rye, plus tankage made an average daily gain of 1.18 pounds, and required 488 pounds of feed for each 100 pounds of gain.

McC Campbell, Ferrin and Winchester (17) fed five lots of ten pigs each to compare various protein supplements when fed with corn. The pigs used in this trial had an initial weight of eighty pounds and were

fed for 100 days. The following rations were hand fed; Lot I corn and tankage, Lot II corn and buttermilk, Lot III corn and linseed meal, Lot IV corn and peanut feed meal, Lot V corn and alfalfa hay. Lot I made an average daily gain of 1.25 pounds, requiring 419 pounds of feed for each 100 pounds of gain. Lot II made an average daily gain of 1.10 pounds requiring 501 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of 1.12 pounds, requiring 480 pounds of feed for each 100 pounds of gain. Lot IV made an average daily gain of 1.17 pounds, requiring 473 pounds of feed for each 100 pounds of gain. Lot V made an average daily gain of 1.16 pounds, requiring 535 pounds of feed for each 100 pounds of gain. Lot V fed the alfalfa hay as the supplement to corn was second in economy of gains, being surpassed by the Lot I fed tankage as a supplement. The alfalfa supplemented groups had the poorest finish, their gains being due principally to growth.

Gramlich and Jenkins (9) fed four lots of twenty pigs each to compare various protein supplements when fed with corn. Eighty, 140 pound pigs were used in this sixty-eight day trial. The following rations were self-fed. Lot I, corn, tankage and alfalfa hay; Lot II, corn and tankage, Lot III, corn and alfalfa hay, and Lot IV corn and ground alfalfa. The average daily gain of the pigs in Lot I was 1.71 pounds. The feed required for each 100 pounds gain was 486 pounds. Lot II made an average daily gain of 1.44 pounds, requiring 411 pounds of feed for each 100 pounds gain. Lot III made a daily gain of 1.08 pounds, requiring 540 pounds of feed for each 100 pounds of gain. Lot IV made a daily gain of .99 pounds, requiring 560 pounds of feed for each 100 pounds of gain. Due to the reduced tankage and corn consumption

when ground alfalfa was fed in Lot I it showed a greater profit although more pounds of feed was consumed. The pigs fed ground alfalfa as a single supplement to corn did not show the finish of the other lots.

Nordby (25) conducted an experiment to determine the effect of adding alfalfa meal to a winter ration for hogs. Two lots of eight pigs each were used in this ninety-eight day trial. The pigs used in this trial had an average initial weight of 85 pounds and were self-fed. Lot I, fed six parts of cracked canadian field peas and fourteen parts of ground barley made an average daily gain of 1.08 pounds and required 472 pounds of feed for each 100 pounds of gain. Lot II fed six parts of crack field peas, fourteen parts of ground barley and one part ground alfalfa hay, made an average daily gain of 1.20 pounds and required 462 pounds of feed for each 100 pounds of gain.

Hunter (13) conducted a 156 day experiment to compare tankage and ground alfalfa hay as supplements to shelled corn. Two lots of ten pigs each, with an average initial weight of 42 pounds were self-fed. Lot I receiving shelled corn, wheat middlings, and tankage made an average daily gain of 1.08 pounds, and required 372 pounds of feed for each 100 pounds of gain. Lot II fed shelled corn, wheat middlings and ground alfalfa hay made an average daily gain of .95 pounds and required 412 pounds of feed for each 100 pounds of gain.

Svoboda (32) reports:

"In a comparative feeding test with four lots of eight pigs each, replacing all animal protein in the ration with alfalfa meal markedly decreased the rate of gain, while a mixed protein supplement containing one-third kilogram of alfalfa meal per head daily plus animal protein produced practically as good gains as the no alfalfa ration and at the same feed cost per unit of gain. No differences was detected in the texture and flavor of the resulting meat."

### Alfalfa as a Portion of the Protein

Weber, Anderson and Marston (36) fed two lots of thirty pigs each sixty-five days to determine the effect of adding alfalfa hay to a corn tankage ration. The pigs were self-fed from an average initial weight of 104 pounds until the close of the trial. Lot I fed corn and tankage, made an average daily gain of 1.21 pounds, and required 393 pounds of feed for 100 pounds of gain. Lot II fed corn, tankage and alfalfa hay in the rack made an average daily gain of 1.45 pounds and required 364 pounds of feed for each 100 pounds of gain.

Kuhlman and Wilson (15) conducted two experiments to compare tankage alone with tankage, linseed meal and alfalfa hay or meal as supplements to corn. Three lots composed of twelve pigs each were used in the trial. In this 105 day trial, pigs with an average initial weight of 45 pounds were used. The rations were self-fed. Lot I receiving corn and tankage made an average daily gain of 1.32 pounds, and required 401.5 pounds of feed for each 100 pounds of gain. Lot II fed corn and the trio mixture made an average daily gain of 1.54 pounds and required 385.6 pounds of feed for each 100 pounds of gain.

In a second experiment at the same station, 56 pound pigs were self-fed for 115 days. Lot I fed corn and tankage made an average daily gain of 1.34 pounds, and required 396.7 pounds of feed for 100 pounds of gain. Lot II fed corn tankage, linseed meal and ground alfalfa hay made an average daily gain of 1.58 pounds and required 370.1 pounds of feed for 100 pounds of gain. Lot III fed corn, tankage, linseed meal and alfalfa hay in racks made an average daily gain of 1.67 pounds and required 380 pounds of feed for 100 pounds of gain.

Nordby (25) conducted an experiment using three lots of eight 80 pound pigs each to compare tankage alone with tankage and alfalfa leaves as a supplement to barley. Lot I fed barley alone made an average daily gain of .84 pounds and required 580 pounds of feed for each 100 pounds of gain. Lot II fed barley, thirteen parts and tankage one part made an average daily gain of 1.30 pounds, and required 480 pounds of feed for each 100 pounds of gain. Lot III fed barley fifteen parts, tankage 1 part and alfalfa leaves one part, made an average daily gain of 1.45 pounds and required 478 pounds of feed for each 100 pounds of gain. Twenty pounds of alfalfa leaves fed to Lot III resulted in a saving of sixteen pounds of barley and six pounds of tankage for 100 pounds of gain when compared to Lot II.

Carroll (4) reports feeding ten pigs with an average initial weight of 22.5 pounds; corn, tankage, and wheat shorts placed in separate compartments of a self-feeder. This ration produced a daily gain of .4 pounds per head over a period of eighty-five days. Alfalfa hay was added to the ration on the eighty-sixth day. The pigs in the last ninety-eight days of the experiment after the addition of alfalfa hay made an average gain of 1.47 pounds per head daily.

Fargo and Bohstedt (8) report a summary of eight years work at the Wisconsin Station comparing alfalfa as a partial supplement to corn. This report summarizes 65 experiments with alfalfa when fed with tankage and linseed meal, as in the trio mixture, and also when fed with tankage or linseed meal alone as a supplement to corn. The lots fed a corn and tankage ration made an average daily gain of .95 pounds, requiring 477 pounds of feed for each 100 pounds gain.

Pigs fed corn, tankage and alfalfa hay gained 1.05 pounds per head daily, requiring 453 pounds of feed for each 100 pounds of gain. Pigs fed corn, tankage, linseed meal and alfalfa meal made an average daily gain of 1.16 pounds per head, requiring 448 pounds of feed for each 100 pounds of gain. Pigs fed corn, tankage, linseed meal and chopped clover hay made a daily gain of 1.12 pounds requiring 442 pounds of feed for 100 pounds gain, showing that well cured clover hay is practically equal to alfalfa hay.

Morrison, Bohstedt, and Steenbock (20) comparing a white corn tankage ration with a yellow corn tankage ration found pigs fed the yellow corn to have one-third higher daily gains. The group fed white corn required 16 per cent more feed for 100 pounds of gain. The addition of five per cent alfalfa meal to a ration of white corn, linseed meal and tankage resulted in making the white corn equal to the yellow corn. In addition to increasing the value of white corn in the fattening ration, alfalfa also improved a yellow corn ration.

Morrison (21) summarizing a years work with various supplements to corn reports pigs fed yellow corn and tankage gained .95 pounds per head daily whereas similar pigs fed linseed meal and alfalfa meal in addition to corn and tankage made a daily gain of 1.21 pounds. The feed required for 100 pounds of gain being reduced 3 per cent.

Morrison (22) reports eight experiments in which pigs fed tankage fifty per cent, linseed meal 25 per cent and alfalfa meal 25 per cent as a supplement to yellow corn made an average gain of 1.16 pounds per head daily; whereas similar hogs fed only yellow

corn and tankage gained only .97 pounds per head daily.

Morrison (23) reports that pigs fed a balanced ration of corn and tankage required 417.9 pounds of corn and 47.9 pounds of tankage for each 100 pounds of gain. Similar hogs fed corn, tankage, linseed meal and alfalfa meal required 378 pounds of corn, 31 pounds of tankage, 19.6 pounds of linseed meal and 19.6 pounds of alfalfa meal for each 100 pounds of gain. The feeding of 19.6 pounds of alfalfa and 19.6 pounds linseed meal resulted in a saving of 39.9 pounds corn and 16.9 pounds tankage for 100 pounds of gain.

Thompson and Hillier (34) report feeding two lots of eight pigs each for eighty-four days in a comparison of tankage alone with tankage and alfalfa meal as a supplement to oats. The pigs used in this trial had an average initial weight of ninety pounds and were self-fed the following rations. Lot I, oats 95 per cent and tankage 5 per cent. Lot II, oats 90 per cent, tankage 5 per cent and alfalfa meal 5 per cent. Lot I made an average daily gain of 1.30 pounds, requiring 410.70 pounds of feed for each 100 pounds of gain. The pigs in Lot II made an average daily gain of 1.70 pounds, requiring 383.22 pounds of feed for each 100 pounds of gain. The addition of 19.16 pounds of alfalfa meal to the ration reduced the oats consumed 42.20 pounds for each 100 pounds of gain.

Robinson (30) reports feeding two lots of 22 pigs each for 142 days. The pigs used in this trial had an average initial weight of 50 pounds and were self-fed. The purpose of the trial was to compare tankage alone with tankage and alfalfa meal as supplements to corn. Lot I fed corn and tankage made an average daily gain of 1.02 pounds, and required 392

pounds of feed for each 100 pounds of gain. Lot II fed corn, tankage, linseed meal, and ground alfalfa hay (which was 3.4 per cent of the total ration) made an average daily gain of 1.14 pounds and required 388 pounds of feed for each 100 pounds of gain. The feeding of alfalfa meal and linseed meal equal parts, increased the rate of gain 21.3 per cent and lowered the feed consumption per unit of gain 5 per cent.

Evvard (7) at the Iowa Station, fed two groups of pigs with an average initial weight of 52 pounds to determine the possibilities of adding alfalfa to a corn tankage ration. The corn and tankage were self-fed free choice. Lot I fed only corn and tankage, reached an average weight of 225 pounds in 115 days. Lot II, receiving a mixture of ground corn, tankage and ground alfalfa hay (percentage of mixture not given) attained an average weight of 225 pounds in 138 days. Lot II consumed less tankage than Lot I but showed less profit due to the longer feeding period.

Wright and Wilson (37) in a 98 day trial compared corn and barley as fattening rations when supplemented with tankage and alfalfa hay. Two lots each composed of seven pigs were used in this trial. The average initial weight of the pigs was 78 pounds. Lot I self-fed shelled corn, tankage and alfalfa hay made an average daily gain of 1.52 pounds and required 425 pounds of feed for each 100 pounds of gain. Lot II self-fed ground barley, tankage and alfalfa hay made an average daily gain of 1.56 pounds and required 448 pounds of feed for each 100 pounds of gain.



The Effect of Different Levels of Alfalfa in a  
Fattening Ration

Scott and Vernon (31) fed four lots of seven pigs each to determine the proper proportion of alfalfa hay that should be fed in a fattening ration for hogs. The pigs used in this trial had an average initial weight of 71 pounds and were fed seventy-three days. Lot I receiving one part alfalfa hay and three parts corn, made an average daily gain of 1.016 pounds, and required 486 pounds of feed for each 100 pounds of gain. Lot II fed equal parts alfalfa hay and corn made an average daily gain of 1.02 pounds, and required 521 pounds of feed for each 100 pounds of gain. Lot III fed three parts alfalfa hay and one part corn made an average daily gain of .59 pounds, and required 668 pounds of feed for each 100 pounds of gain. Lot IV fed alfalfa hay alone made an average daily gain of .21 pounds and required 1,566 pounds of feed for 100 pounds of gain.

Thompson (33) reports feeding four lots of nine pigs each to study the effects of various proportions of alfalfa meal in a fattening ration. The pigs used in this trial had an average initial weight of 79 pounds and were on the experiment seventy-five days. Lot I self-fed ground kafir and a protein supplement composed of ten parts tankage and 1 part alfalfa meal made an average daily gain of 1.09 pounds, and required 483 pounds of feed for each 100 pounds of gain. Lot II self-fed ground kafir and a protein supplement composed of five parts tankage, five parts cottonseed meal and one part alfalfa meal made an average daily gain of 1.20 pounds, and required 489 pounds of feed for 100 pounds of gain. Lot III self-fed ground kafir, tankage and

alfalfa hay in racks made an average daily gain of 1.17 pounds and required 527 pounds of feed for 100 pounds of gain. Lot IV self-fed ground kafir, five parts of tankage and one part of alfalfa meal made an average daily gain of 1.30 pounds and required 424 pounds of feed for each 100 pounds of gain. The increase of alfalfa meal in Lot IV resulted in a 16 per cent increase in rate of gain and decreased the feed required per unit of gain 12 per cent.

Headley (10) in a 138 day trial fed twenty-four 28 pound pigs to determine the per cent alfalfa a fattening ration could contain most profitably. The pigs were divided into four lots of six each and fed the following rations: Lot I, two pounds of barley to each 100 pounds live weight, plus access to alfalfa hay in the rack. Lot II, 70 per cent barley, 30 per cent alfalfa meal. Lot III, 80 per cent barley and 20 per cent alfalfa meal. Lot IV, 90 per cent barley and 10 per cent alfalfa meal. Skimmilk was fed to each of the lots at the daily rate of 10 per cent of the weight of the pigs. Lot I made a daily gain of 1.03 pounds, requiring 277 pounds of barley, 940 pounds of skimmilk and 92 pounds of alfalfa hay for each 100 pounds gain. Lot II made a daily gain of 1.14 pounds, requiring 297 pounds of barley, 975 pounds of skimmilk and 128 pounds of alfalfa meal for 100 pounds of gain. Lot III made a daily gain of 1.34 pounds, requiring 294 pounds of barley, 800 pounds of skimmilk and 74 of alfalfa meal for 100 pounds gain. Lot IV made a daily gain of 1.36 pounds, requiring 322 pounds of barley, 787 pounds of skimmilk and 36 pounds of alfalfa meal for each 100 pounds of gain.

Aubel and Anderson (1) report comparing varying proportions of

alfalfa meal when fed as a partial supplement to a corn ration. Four lots of nine pigs each were used in this trial. The pigs had an average initial weight of 71 pounds and were self-fed for 120 days. Lot I fed a ration composed of corn, tankage and alfalfa hay made an average daily gain of 1.71 pounds and required 447 pounds of feed for each 100 pounds of gain. Lot II fed corn and a protein supplement composed of two parts tankage, one part cottonseed meal and one part alfalfa meal made an average daily gain of 1.73 pounds, and required 408 pounds of feed for 100 pounds of gain. Lot III fed corn and a protein supplement composed of three parts tankage and one part alfalfa meal made an average daily gain of 1.70 pounds and required 400 pounds of feed for 100 pounds of gain. Lot IV fed corn, and a protein supplement composed of nine parts of tankage and 1 part of alfalfa meal made an average daily gain of 1.64 pounds and required 408 pounds of feed for 100 pounds of gain.

Rice (23), working at the Georgia Station conducted numerous trials to determine the correct amount of alfalfa meal to be fed in a hog ration. The results indicated that about five per cent of the total ration could profitably be composed of alfalfa meal. Rations containing more than five per cent apparently had more crude fiber than could be economically digested by the hogs.

Petersen and Jespersen (26) report feeding alfalfa meal in varying proportions, as a supplement to a ration composed of wheat, barley and maize. Lot I fed barley, wheat and maize made a daily gain of 1.32 pounds, requiring 372 pounds of feed for each 100 pounds of gain. Lot II fed the same ration except alfalfa meal was substituted

for five per cent of it made a daily gain of 1.33 pounds, requiring 361 pounds of feed for each 100 pounds of gain. Lot III fed the same basal ration except alfalfa meal was substituted for 10 per cent of the feed made a daily gain of 1.36 pounds, requiring 363 pounds of feed for each 100 pounds of gain. Lot IV fed same basal ration with 14 per cent of it composed of alfalfa meal made an average daily gain of 1.25 pounds, requiring 383 pounds of feed for each 100 pounds of gain. The results of this trial would indicate that it is not profitable to feed a ration composed of more than 10 per cent alfalfa meal, as the basal ration alone made higher gains.

Zeller and Ellis (39) report two experiments to determine the correct proportion of alfalfa meal to feed in a fattening ration for hogs. Five lots, composed of eight 45 pound hogs each were fed for 115 days. The lots were fed the following rations. Lot I, corn 86%, tankage 9%, linseed meal 4%, and mineral 1%. Lot II, corn 82%, tankage 8%, linseed meal 40%, and alfalfa meal 5%, and mineral 1%. Lot III corn 78%, tankage 7%, linseed meal 4%, alfalfa meal 10%, and mineral 1%. Lot IV corn 74%, tankage 6%, linseed meal 4%, alfalfa meal 15%, and mineral 1%. Lot V, corn 70%, tankage 5%, linseed meal 4%, alfalfa meal 20%, and mineral 1%. Lot I made an average daily gain of 1.51 pounds, requiring 374 pounds of feed for each 100 pounds of gain. Lot II made an average daily gain of 1.60 pounds requiring 398 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of 1.61 pounds requiring 394 pounds of feed for each 100 pounds of gain. Lot IV made an average daily gain of 1.41 pounds requiring 413 pounds of feed for each 100 pounds

of gain. Lot V made an average daily gain of 1.46 pounds, requiring 408 pounds of feed for each 100 pounds of gain.

The second experiment was conducted with five lots of ten, 58 pound pigs fed the same ration as the first for ninety days. Lot I made an average daily gain of 1.68 pounds requiring 343 pounds of feed for each 100 pounds of gain. Lot II made a daily gain of 1.88 pounds requiring 357 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of 1.83 pounds requiring 361 pounds of feed for each 100 pounds of gain. Lot IV made an average daily gain of 1.57, requiring 376 pounds of feed for each 100 pounds of gain. Lot V made an average daily gain of 1.57 pounds, requiring 402 pounds of feed for each 100 pounds of gain. The results of the two experiments show that pigs fed a ration composed of five or ten per cent alfalfa meal made the most satisfactory gains. Lot V, fed a ration composed of 20 per cent alfalfa meal made approximately as good gains as the check group fed no alfalfa. The trial seemed to indicate that hogs cannot utilize a ration composed of more than twenty per cent alfalfa meal.

### Alfalfa as a Source of Vitamins A and D

Zeller and Ellis (39) state in the 1939 yearbook of agriculture:

"Alfalfa meal made by grinding alfalfa hay is fairly rich in protein and minerals and is a good source of vitamins A and D. On account of its bulk it should not be fed as the sole protein supplement to fattening pigs, but it may be combined with other more concentrated proteins. Alfalfa leaf-meal has higher protein and a lower crude-fiber content and is usually higher in price than alfalfa meal. In comparing the two from the standpoint of economy, the vitamin and mineral content should be considered in relation to the need of the hogs for these nutritive essentials. Alfalfa meal or ground alfalfa hay can be fed efficiently at a level of 5 or 10 per cent of the total ration or even 15 to 20 per cent when the ration is balanced otherwise. As a home grown protein supplement, the use of alfalfa meal may reduce the amount of higher priced protein feeds that must be purchased."

Maynard, Goldberg, and Miller (16) studying dietary relationships and stiffness in swine, fed eleven pigs, ten weeks of age the following ration: yellow corn meal, wheat middlings, casein, raw skimmilk, precipitated calcium phosphate and ground limestone. The pigs were housed and did not have access to direct sunlight. Five of the pigs developed "stiffness" after eight weeks feeding in the trial. Four other pigs later developed stiffness and died. The ration of the two remaining pigs was then altered to include 5 c.c. of cod liver oil and alfalfa meal was added up to 5 per cent of the total ration which resulted in improvement and final disappearance of the stiffness.

Powell (27) of the Purina experimental farm reports an experiment which included 300 hogs to determine the deficiencies of a yellow corn and tankage ration. The pigs with an average initial weight of 52 pounds were divided into twelve lots of 25 pigs each. Two of the lots were self-fed tankage and number 2 yellow corn. The remaining ten lots were fed the trio mixture and other more complex protein

supplements with number 2 yellow corn. The pigs in the corn and tankage fed lots on about the forty-fourth day of the experiment became unable to handle their legs and had large pockets of liquid apparently joint oil about the joints. Other groups fed the trio mixture, which is composed of 25 per cent alfalfa meal in addition to cottonseed meal and tankage did not develop this lameness and swelling of the joints. Feeding a different mineral supplement and cod liver oil did not improve the affected hogs.

Hostetler and Foster (11) report feeding two lots of 30 pigs each, 66.5 days to determine the effect of adding ground alfalfa hay to a white shelled corn, fish meal ration. The average initial weight of the pigs was 98.4 pounds. Lot I was self-fed white shelled corn and fish meal. Lot II was self-fed white shelled corn and a mixture of 3 parts fish meal and 1 part ground alfalfa hay. Lot I made an average daily gain of 1.98 pounds requiring 370 pounds of feed for each 100 pounds gain. Lot II made an average daily gain of 2.09 pounds, requiring 377 pounds of feed for 100 pounds gain. The results show that for pigs weighing approximately 100 pounds and having been on green pasture before the start of the experiment, it is not necessary to add alfalfa to prevent a vitamin A deficiency on a sixty day experiment. The addition of alfalfa hay was valuable however, due to the reduction in consumption of the fish meal and also the increase in daily gain.

Hostetler and Halverson (12) summarizing the results of one experiment report that pigs which were fed white corn, fish meal and mineral quit eating, developed lameness and in some cases died. The vitamin deficiency occurred in the spring from fall farrowed pigs.

The substitution of yellow corn for white corrected the trouble. The addition of 6 per cent alfalfa meal in the ration also corrected the trouble.

Dunlop (6) reports the feeding of ten lots of three pigs each to determine a ration that would supply sufficient vitamin A for normal growth and storage. The pigs had an average initial weight of 36 pounds. They were fed the following rations: Lot I, barley meal 84 parts, extracted soybean meal 16 parts. Lot II, barley meal 84 parts, fish meal 16 parts. Lot III, barley meal 60 parts, weatings 24 parts, and extracted soybean meal 16 parts. Lot IV, barley meal 24 parts, weatings 60 parts, extracted soybean meal 16 parts. Lot V, barley meal 60 parts, rice meal 24 parts and extracted soybean meal 16 parts. Lot VI, rice meal 84 parts and extracted soybean meal 16 parts. Lot VII, barley meal 60 parts, maize meal 24 parts and extracted soybean meal 16 parts. Lot VIII, barley meal 24 parts, maize meal 60 parts and extracted soybean oil meal 16 parts. Lot IX, barley meal 60 parts, weatings 24 parts, extracted soybean oil meal 14 parts and alfalfa meal 2 parts. Lot X, barley meal 60 parts, weatings 24 parts, extracted soybean meal 10 parts and alfalfa meal 6 parts.

The rations fed Lots I to VII inclusive were deficient in vitamin A as most of the animals developed deficiency symptoms before the end of the trial. There was also no storage of the vitamin in the liver. Lot VIII fed a ration composed of sixty per cent maize meal apparently obtained sufficient vitamin A as there was a small amount stored in the liver at the time they were slaughtered. Lot IX fed two per cent alfalfa meal did not develop the vitamin A deficiency symptoms. There



was no vitamin A stored in the liver, however. Lot X fed a ration composed of 6 per cent alfalfa meal had a very low storage of vitamin A. A ration composed of six per cent alfalfa appeared to have too much bulk for maximum growth.

Robison and Bohstedt (29) studying the vitamin and mineral requirements of pigs, fed five lots of six 42 pound pigs 175 days. The following rations were self-fed. Lot I, ground white corn 75 per cent, wheat middlings 9 per cent, and linseed meal 15 per cent. Lot II was fed the same ration except two pounds of ground limestone was added. Lot III basal ration plus two pounds of ground limestone and .5 per cent of the total ration made up of codliver oil. Lot IV, basal ration plus five pounds of alfalfa meal. Lot V, basal ration plus 5 pounds of alfalfa meal and two pounds of ground limestone. Lot I made an average daily gain of .44 pounds, requiring 516 pounds of feed for each 100 pounds of gain. Lot II made an average daily gain of .49 pounds requiring 557 pounds of feed for each 100 pounds of gain. Lot III made an average daily gain of .81 pounds, requiring 459 pounds of feed for each 100 pounds of gain. Lot IV made an average daily gain of .28 pounds, requiring 947 pounds of feed for 100 pounds of gain. Lot V made an average daily gain of .59 pounds, and required 475 pounds of feed for 100 pounds of gain.

### Digestibility of Alfalfa Meal

Mitchell and Hamilton (19) report feeding a barrow weighing 178 pounds, 1200 grams of alfalfa meal daily. The purpose of the trial was to determine the digestibility of alfalfa meal. The ration in which the alfalfa meal was fed contained 27.51 per cent alfalfa meal, 3 per cent mineral mixture, 5 per cent sucrose, and 64.49 per cent corn starch. The alfalfa meal used in the trial contained 10.50 per cent water, 13.44 per cent crude protein, 2.16 per cent of ether soluble material, 7.61 per cent ash, 29.26 per cent crude fiber, and 37.03 per cent nitrogen, free extract. Its gross energy content was 5.95 calories per gram.

The coefficients of apparent digestibility of the alfalfa meal were 79.7 for dry matter, 37.5 for crude protein, 94.0 for nitrogen free extract, and 78.5 for gross energy. The true digestibility is represented by the following coefficients, 45.9 for crude protein, 71.1 for nitrogen free extract, 1.9 for crude fiber and 38.6 for energy. The digestibility of the ether extract could not be computed, due to the presence of more fat in the feces than was in the feed. The total digestible nutrients amounted to 31.3 per cent.

Morrison (24) reports from digestion trials using wethers and steers the digestion coefficients of alfalfa meal to be: protein 71, fat 30, nitrogen free extract 73, and fiber 50. The total digestible nutrients were 53.9 per cent.

TABLE I  
SUMMARY OF TRIALS REVIEWED

| Station  | Lot Number | Reference Number | Initial Weight | Number Days Fed | Rate of Gain | Basalration                | Alfalfa  | Feed per 100 lbs. Gain |
|----------|------------|------------------|----------------|-----------------|--------------|----------------------------|----------|------------------------|
| Okla.    | 3          | 33               | 90.75          | 84              | 1.70         | Oats, 90, tankage          | Meal 5%  | 383.23                 |
| Okla.    | 1          | 34               | 78.0           | 75              | 1.07         | Kafir corn tankage         | Meal     | 467.6                  |
| S. Dak   | 10         | 15               | 74.1           | 101             | 1.52         | Corn tankage               | Hay      | 442.9                  |
| S. Dak   | 12         | 15               | 74.0           | 96              | 1.56         | Ground barley tankage      | Hay      | 448.9                  |
| S. Dak   | 19         | 15               | 81.3           | 80              | 1.85         | Shelled corn tankage       | Hay      | 380.5                  |
| S. Dak   | 20         | 15               | 81.0           | 105             | 1.38         | Ground barley tankage      | Hay      | 464.6                  |
| S. Dak   | 31         | 37               | 146.3          | 58              | 1.89         | Shelled corn tankage       | Hay      | 317.6                  |
| S. Dak   | 32         | 37               | 145.5          | 58              | 1.65         | Ground barley tankage      | Hay      | 376.23                 |
| U.S.D.A. | 2          | 38               | 45.0           | 115             | 1.74         | Yellow corn tankage L.S.M. | Meal 5%  | 377.5                  |
| U.S.D.A. | 3          | 38               | 45.0           | 115             | 1.70         | Yellow corn tankage        | Meal 10% | 377                    |
| U.S.D.A. | 4          | 38               | 58.0           | 90              | 1.64         | Yellow corn tankage        | Meal 15% | 394.5                  |
| U.S.D.A. | 5          | 38               | 58.0           | 90              | 1.58         | Yellow corn tankage        | Meal 20% | 405                    |

Summary of Trials Reviewed (contd)

| Station   | Lot Number | Reference Number | Initial Weight | Number Days Fed | Rate of Gain | Basalration                            | Alfalfa     | Feed per 100 lbs. Gain |
|-----------|------------|------------------|----------------|-----------------|--------------|--|-------------|------------------------|
| Nebr.     | 1          | 9                | 137.5          | 70              | 1.56         | Corn-tankage                           | Hay         | 485                    |
| Nebr.     | 2          | 9                | 135.9          | 70              | 1.13         | Corn-shorts                            | Hay         | 530                    |
| Nebr.     | 3          | 9                | 134.3          | 70              | 1.67         | Corn-shorts tankage                    | Hay         | 479                    |
| Montana   | 1          | 35               | 54.9           | 118             | 1.23         | Winter rye - barley<br>2.64 lbs. daily | Hay         | 486                    |
| Miss.     | 2          | 2                | 104.7          | 84              | 1.37         | Corn                                   | Meal        | 479.1                  |
| Kansas    | 2          | 5                | 125.0          | 65              | 1.32         | Kafir                                  | Meal        | 616                    |
| Kansas    | 14         | 18               | 138.0          | 112             | 1.18         | Corn meal                              | Hay         | 697                    |
| Nevada    | 4          | 10               | 43.3           | 114             | 0.95         | Corn middlings; tankage                | Ground Hay  | 412.91                 |
| Pa.       | 4          | 18               | 107.5          | 74              | .31          | Cornmeal                               | Hay         | 1320                   |
| Col.      | 1          | 3                | 68.0           | 91              | 1.17         | Corn                                   | Meal        | 583                    |
| Col.      | 2          | 3                | 68.0           | 91              | 1.26         | Corn, barley                           | Hay         | 502                    |
| Idaho     | 2          | 25               | 85.0           | 98              | 1.20         | Peas, barley                           | Hay         | 462                    |
| N. Mexico | 1          | 31               | 71.0           | 73              | 1.01         | Corn, 3 parts                          | Hay, 1 part | 486                    |

### Experimental

The objects of this experiment were as follows:

1. To show the need for a carotene supplement in a ration composed of ground barley, tankage and cottonseed meal.
2. To determine the supplementary value of alfalfa meal when added to a basal ration of barley, tankage and cottonseed meal.
3. To compare dehydrated alfalfa leaf meal and ground, sun cured, alfalfa hay in rations for growing and fattening swine.

### Method of Procedure

Forty head of purebred pigs with an average initial weight of 98 pounds were divided as evenly as possible into four lots of ten pigs each. The pigs used were both gilts and barrows of each of the breed represented in the college herd, namely, Duroc Jersey, Poland China, Hampshire and Berkshire.

The pigs were all housed in the same set of feeding sheds and lots. The sheds and lots were of uniform size, had concrete floors and were opened to the south.

The pigs were self-fed free choice and had access to water and minerals at all times. The mineral mixture being composed of equal parts of salt, steamed bone meal and powdered limestone.

The barley used in this trial weighed 42.5 pounds to the bushel and graded "sample." It was ground in a hammer mill with a 1/8 inch screen. Regular digester tankage, containing 60 per cent crude protein was fed in all rations. The cottonseed meal fed to all lots contained 43 per cent crude protein. The dehydrated alfalfa leaf meal contained 20 per cent crude protein. It was of excellent color and quality, and contained 100 parts of carotene per million. High quality, third cutting, sun cured alfalfa hay, containing 31 parts of carotene per million was used. It was ground with a hammermill with a 3/32 inch screen. The commercial carotene supplement used was an extract from carrots. It contained 1982 parts of carotene per million.

## Rations

(Self-fed free choice)

Lot I received a ration composed of ground barley, and a protein supplement composed of 75 parts tankage and 25 parts cottonseed meal.

Lot II received a ration composed of ground barley, and a protein supplement composed of 75 parts of tankage and 25 parts of cottonseed meal. Sixty c.c. of a commercial carotene supplement was mixed with approximately ten pounds of ground barley and placed in the feeder trough daily.

Lot III received a ration composed of ground barley, and a protein supplement composed of tankage 50 parts, cottonseed meal 25 parts and dehydrated alfalfa leaf meal 25 parts.

Lot IV received a ration composed of ground barley and a protein supplement composed of tankage 50 parts, cottonseed meal 25 parts, and ground alfalfa hay 25 parts.

A mineral mixture composed of equal parts salt, steamed bone meal and powdered limestone was self-fed, free choice to all lots.

## Results

Lot I fed only the basal ration made an average daily gain of only .98 pound, and required 557.21 pounds of feed for each 100 pounds of gain. A comparison of Lots I and II indicate that the absence of a carotene supplement in Lot I was largely responsible for the low daily gain and high feed requirement per unit of gain in their group.

Lot II fed the carotene supplement in addition to the basal ration, made an average daily gain of 1.42 pounds, and required 394.69 pounds of feed for each 100 pounds of gain. The results show .84 pound of the commercial carotene supplement saved 143.86 pounds of ground barley, 9.77 pounds of tankage, 3.25 pounds of cottonseed meal, and 1.48 pounds of mineral in producing 100 pounds of gain. In other words, for each 29¢ (.84 pound) spent for carotene \$1.84 was saved on barley, tankage, cottonseed and mineral or a net saving of \$1.55 when one considers only the increase in weight on the hogs.

Lot III fed dehydrated alfalfa leaf meal in addition to the basal ration made an average daily gain of 1.46 pounds and required 385 pounds of feed for each one hundred pounds of gain. The addition of dehydrated alfalfa leaf meal resulted in a saving of 9.76 pounds of tankage, 168.3 pounds of barley, .45 pounds of cottonseed meal, and 1.86 pounds of mineral as shown by a comparison of Lots III and I. That is to say, that for each 14¢ expenditure for dehydrated alfalfa leaf meal, \$1.84 was saved on barley, tankage, cottonseed meal, and mineral. This gives the dehydrated alfalfa leaf meal a value of \$21.82 per one hundred pounds.



A comparison of Lots II and III reveals that the addition of 8.43 pounds of dehydrated alfalfa leaf meal fed in Lot III resulted in a saving of 18.44 pounds of barley, .37 pounds of mineral, and .84 pounds of carotene supplement for 100 pounds of gain. Practically identical amounts of tankage were required in these lots. In other words the cost of the dehydrated alfalfa meal plus the cost of the extra cottonseed meal used in Lot III amounted to 19¢. This amount subtracted from the cost of the additional barley, mineral and the carotene supplement fed in Lot II which amounted to 51¢, would result in a net saving of 32¢ for 100 pounds of gain.

Lot IV fed ground, sun cured alfalfa hay in addition to the basal ration made an average daily gain of 1.34 pounds, and required 398.17 pounds of feed for each 100 pounds of gain. The addition of 6.79 pounds of ground alfalfa hay resulted in a saving of 13.04 pounds of tankage, 140.30 pounds of barley, 2.03 pounds of cottonseed meal, and .41 pounds of mineral as shown by a comparison of Lots I and III. That is to say, that for each 5¢ worth of ground alfalfa hay fed, \$1.35 was saved on barley, tankage, cottonseed meal and mineral. Considering only the increase in weight on the hogs, the ground alfalfa hay proved to be worth \$27.75 per one hundred pounds as shown by a comparison of Lots I and IV.

A comparison of Lots II and IV show 8¢ spent for ground alfalfa hay and the additional cottonseed meal and mineral required to produce 100 pounds of gain, resulted in a saving of 31¢ in barley, tankage and carotene supplement for 100 pounds of gain.

A comparison of Lots III and IV show that the feed cost was

identical, the ration fed Lot III having a slight advantage due to a .12 pound larger gain per head daily.

TABLE II  
 CAROTENE IN RATIONS FOR GROWING AND FATTENING SWINE IN DRY LOT  
 February 25 to May 11, 1940

| Lot No.   | Lot I                                      | Lot II   | Lot III  | Lot IV   |
|---|--|--|--|--|
|   | Gr. Barley<br>Tankage<br>C.S.M.<br>Mineral | Gr. Barley<br>Tankage<br>C.S.M.<br>Mineral<br>Carotene<br>Suppl. | Gr. Barley<br>Tankage<br>C.S.M.<br>D. Alf. Leaf<br>Meal<br>Mineral | Gr. Barley<br>Tankage<br>C.S.M.<br>Gr. Alf. Hay<br>Mineral |
| Pigs Per Lot  | 10   | 10   | 10   | 10   |
| Av. Initial Wt.                                     | 98.1                                       | 98   | 99.1   | 98.9   |
| Av. Final Wt.                                       | 173.6                                      | 207  | 211.2  | 202.4  |
| Av. Total Gain                                      | 75.5                                       | 109  | 112.1  | 103.5  |
| Av. Daily Gain                                      | .93  | 1.42   | 1.46   | 1.34   |
| Feed Required per<br>100 lbs. Gain:                 |  |  |  |  |
| Ground Barley                                       | 516.29                                     | 367.43   | 347.99   | 365.99   |
| Tankage   | 26.62                                      | 16.85  | 16.86  | 13.59  |
| Dehydrated alfalfa<br>leaf meal                     |  |  | 8.43   |  |
| Ground, sun cured<br>alfalfa hay                    |  |  |  | 6.79   |
| Cottonseed meal                                     | 8.87                                       | 5.62   | 8.42   | 6.79   |
| Carotene Supplement                                 |  | .84  |  |  |
| Mineral Mixture                                     | 5.43                                       | 3.95   | 3.57   | 5.02   |
| Total Feed Required to<br>Produce 100 lbs. of Gain: | 557.21                                     | 394.69   | 335.23   | 398.17   |
| Cost of 100 lbs. of Gain                            | 6.11                                       | 4.57   | 4.23   | 4.26   |

Table II (contd)

| Feed Prices Used (100 pound basis) |        |                              |      |
|------------------------------------|--------|------------------------------|------|
| Ground Barley                      | \$1.00 | Ground Alfalfa Hay           | .68¢ |
| Tankage                            | 2.75   | Mineral Mixture              | 1.23 |
| Cottonseed Meal                    | 1.70   | Carotene Supplement(per lb.) | .35¢ |
| Dehydrated Alfalfa Leaf Meal       | 1.70   |                              |      |

TABLE III  
 AVERAGE FEED CONSUMED DAILY PER PIG BY LOTS

|                                 | Lot I | Lot II | Lot III | Lot IV |
|---------------------------------|-------|--------|---------|--------|
| Barley                          | 5.06  | 5.20   | 5.06    | 4.92   |
| Supplement                      | .35   | .32    | .49     | .36    |
| Tankage                         | .26   | .24    | .25     | .18    |
| Cottonseed Meal                 | .09   | .08    | .12     | .09    |
| Ground Alfalfa Hay              |       |        |         | .09    |
| Dehydrated Alfalfa<br>Leaf Meal |       |        | .12     |        |
| Carotene Supplement             |       | .012   |         |        |
| Minerals                        | .05   | .06    | .05     | .07    |
| Total                           | 5.81  | 5.912  | 6.09    | 5.71   |

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TABLE IV

TOTAL FEED CONSUMED PER LOT

|                                     | Lot I     | Lot II    | Lot III   | Lot IV    |
|-------------------------------------|-----------|-----------|-----------|-----------|
| Barley                              | 3898      | 4005      | 3901      | 3788      |
| Supplement                          | 268       | 245       | 378       | 281       |
| Tankage                             | 201       | 183.75    | 189       | 140.5     |
| Cottonseed Meal                     | 67        | 61.25     | 94.5      | 70.25     |
| Ground Alfalfa Hay                  |           |           |           | 70.25     |
| Dehydrated Alfalfa<br>Leaf Meal     |           |           | 94.5      |           |
| Carotene Supplement                 |           | 9.14      |           |           |
| Mineral                             | <u>41</u> | <u>43</u> | <u>40</u> | <u>52</u> |
| Total                               | 4107      | 4120.89   | 4319      | 4149.20   |
| Nutritive Ratio                     | 1:5.3     | 1:5.7     | 1:5.4     | 1:5.8     |
| Per cent of Total<br>Ration Alfalfa | 0         | 0         | 2.1       | 1.7       |

## DISCUSSION

The results from this experiment agree with the work of Morrison and associates (20) that the addition of small amounts of ground alfalfa hay to a fattening hog ration composed of the cereal grains, cottonseed meal and tankage result in an improvement of the ration, namely a reduction in consumption of feed per unit of gain and higher daily gains.

No attempt was made in this experiment to determine the largest percentage of the total ration that could be composed of alfalfa meal and economically utilized by fattening hogs. The pigs were self-fed free choice and by balancing their own ration consumed alfalfa meal up to 2 per cent of the total ration. Rice (23) and Nordby (25) believe that a fattening hog ration should be composed of not more than 5 per cent alfalfa meal. Zeller and Ellis (33) also secured the best results with rations containing not more than 5 per cent alfalfa meal.

It is possible that the barley, tankage or cottonseed meal carried small amounts of carotene or vitamin A, and thus that the ration fed Lot I was not entirely devoid of carotene or vitamin A. However, it is quite apparent that it did not carry enough carotene for maximum growth. A lack of growth was the only visible evidence of a lack of carotene.

No attempt was made to determine the vitamin A storage in any of the pigs used in this trial either at the beginning or the end of the trial. The fact that very little pasture was available for these pigs

from birth until the start of the trial and that they had been on a ration in which ground kafir and ground barley were the principal source of nutrients would lead one to believe that they had a small storage of vitamin A. Also it was noted that Lot I made low gains from the beginning of the trial which would indicate a very small storage of vitamin A.

This would indicate that there may be many herds of swine over the state fed on rations similar to that fed Lot I which show no evidences of an acute lack of vitamin A, yet may be making slow and inefficient gains. Such a deficiency can be easily corrected as shown by a comparison of Lot I with Lots II, III and IV.

Further and more detailed studies need to be made to determine the amount of carotene required by swine of various ages and on a wide variety of rations under experimental and practical feed yard conditions.



## SUMMARY

The literature reviewed reveals that experiments conducted with alfalfa as a feed for hogs have been for the most part to determine its ability to supplement either part or all of the animal protein such as tankage. These experiments demonstrate that alfalfa is not satisfactory when fed as a single supplement to a grain ration. The literature reviewed also indicates that high quality, sun cured, alfalfa hay is a very good source of carotene when added to rations commonly fed fattening hogs.

The experiment presented in this thesis demonstrates the need for carotene in some of the rations commonly fed swine in Oklahoma.

Four lots composed of ten pigs each, were fed for 79 days. The average initial weight of the pigs was 98 pounds. Lot I, self-fed a ration composed of barley, tankage and cottonseed meal, made an average daily gain of .98 pounds. Lot II, self-fed a commercial carotene supplement in addition to the basal ration, made an average daily gain of 1.42 pounds. Lot III, self-fed dehydrated alfalfa leaf meal made an average daily gain of 1.46 pounds. Lot IV, self-fed ground, sun cured alfalfa hay made an average daily gain of 1.42 pounds. When the feed cost per unit of gain was compared, it was found that either the commercial carotene supplement, dehydrated alfalfa leaf meal or ground, sun cured alfalfa hay are satisfactory carotene supplements to a grain ration, and that a carotene supplement was necessary for economical production.

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STRAVINSKY  
LUDWIG

Typist: Pauline Streeter

CHINESE