THE FEASIBILITY OF ESTABLISHING A FEED ANALYTICAL SERVICE FOR MICHIGAN CATTLE FEEDERS

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ABSTRACT

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A FEED ANALYTICAL SERVICE FOR
MICHIGAN CATTLE FEEDERS

by William Lee Bortel

A feed analytical study was conducted in Gratiot County, Michigan, between January and June, 1965, to determine the value of conducting proximate analyses of corn silage and the complete ration being fed feedlot cattle. Eight cattle feeders were selected for the study which were following the same type of feeding program, utilizing similar feeds and feeding similar cattle. In all cases, each cooperator was attempting to follow a feeding program consisting of a full feed of corn silage with a one percent of body weight in concentrates.

The degree of variation within and between farms of the proximate analyses of the corn silage and the complete ration being fed on each of the eight farms was the basis of the study. Each feedlot was visited unannounced once each month and samples of the corn silage and the complete ration were taken. Samples were sealed in an airtight container, frozen and transferred to the Biochemistry Laboratory at Michigan State University for proximate analyses. Duplicate samples are the basis of all results which were analyzed according to the methods outlined in the Tenth Edition of the Association of Agriculture Chemists.

The following general conclusions may be drawn, based on the summary of the data.

1. A great deal of variation existed from month to month within and between farms for percent moisture in corn silage and

the complete ration. Therefore, corn silage and other high moisture feed ingredients must be analyzed for moisture as frequently as once a month in order to know with any degree of accuracy the dry matter content of ingredients being fed.

2. Likewise, an equal amount of variation existed from month to month within and between farms for percent ash, percent crude fiber, percent ether extract, percent crude protein, percent nitrogen free extract, and percent total digestible nutrients on a calculated basis. However, the mean value for all six samples for each analysis conducted for each farm did not vary substantially from values shown in Morrison's standards. Thus, it appears that values shown in Morrison's standards are equally acceptable to the mean value of six samples conducted and is a far better estimate than any one single sample conducted.

3. Based on the results of this study, the establishment of a feed analytical service for Michigan cattle feeders is not warranted at the present time.

Based on the above conclusions, the following general recommendations may be made. Cattle feeders utilizing silages and other high moisture ingredients to formulate their rations should test for dry matter as frequently as once per month. By using dry matter values in combination with Morrison's published average analyses standards, proximate analyses of the corn silage sample in question may be calculated and feeding programs and supplements adjusted accordingly.

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By

William Lee Bortel

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William Lee Bortel

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INTRODUCTION

A nation-wide soil testing service has been available for more than 25 years. It is now an accepted policy for farmers to test their soils periodically and fertilizer recommendations for specific crops are made accordingly. The question often arises, "why not have a similar service for cattle feeders, in which they could submit samples of feeds fed and balance rations and add supplements accordingly.

Renewed interest by Michigan cattle feeders in a feed analytical service in recent years has been brought about due to the competitive nature of the cattle feeding business and the cost-price squeeze that cattle feeders now find themselves in.

A number of informal conferences have been held by research workers and extension personnel at Michigan State University, as well as personnel of the State Department of Agriculture to explore the desirability of establishing a feed analytical service for Michigan livestock men. It was the consensus of this group that further research and study should be made on the benefits to be accrued by livestock men before a feed analytical service is established or the idea abandoned.

Therefore, in light of this, the specific objectives of this study were to:

(1) Determine variation in proximate analysis of corn silage during a six month's feeding period within and between a selected group of cattle feeders.

(2) Determine the accuracy of a selected group of cattle feeders to balance rations over a six month's feeding period without the aid of proximate analyses of ingredients fed.

(3) Estimate nutritional improvement of rations fed and monetary savings derived from monthly proximate analyses of corn silage and the complete ration over a six month's feeding period.

LITERATURE REVIEW

The practice of routinely analyzing feeds for the purpose of nutritionally balancing rations and as an aid in establishing the monetary value of feedstuffs is not new. As a matter of fact, it has been employed as a management tool since the "Weende" method of proximate analyses was first established in 1864. It is a routine procedure for virtually all large scale western feedlot operators. Its usage by farmer feeders in the midwest has increased vastly in recent years. Virtually all states now have access to some type of a feed analytical service, either governmental or privately sponsored and in most cases, the service is on a fee basis. However, feed companies and other farm service groups do provide a free analytical service to their clients in some instances.

In addition to their regulatory function, the Michigan State Department of Agriculture has provided a non-publicized analytical service for Michigan livestock men. The types of analyses conducted and the fee schedule is shown in Table 1. The volume of samples that the State Department of Agriculture laboratory can handle is extremely limited and the service is secondary to their regulatory function. If the volume of samples increases vastly over the present number of approximately forty-eight annually, a separate and distinct analytical service would have to be established reports Carr (1966).

Feed Analytical Services available in other States

A letter of inquiry concerning feed analytical services availa-

ble to farmers was written to the extension Animal Husbandry project leader in forty-one states. As shown in Table 2, seventeen states operate a feed analytical laboratory with ten states having an analytical service for roughages only and seven states providing a service for both roughages and concentrates, or the complete ration.

Table 1. MICHIGAN DEPARTMENT OF AGRICULTURE -- LABORATORY DIVISION
1615 South Harrison Road, East Lansing, Michigan 48823

SERVICE SAMPLE FEES ESTABLISHED BY MICHIGAN COMMISSION OF AGRICULTURE

COMMERCIAL FEEDS:	
Ash in Feed	$ 3.00
Digestible Animal Protein	$ 5.00
Drug in Feed	$10.00
Fat in Feed	$ 3.00
Fiber in Feed	$ 5.00
Moisture in Feed	$ 3.00
Protein in Feed	$ 3.00
Urea (non-protein nitrogen)	$ 5.00
Vitamin in Feed	$10.00
Calcium in Mineral Feed	$ 5.00
Cobalt in Mineral Feed	$10.00
Copper in Mineral Feed	$ 5.00
Fluorine in Mineral Feed	$20.00
Iodine in Mineral Feed	$ 5.00
Iron in Mineral Feed	$10.00
Magnesium in Mineral Feed	$10.00
Maganese in Mineral Feed	$10.00
Phosphorus in Mineral Feed	$ 5.00
Salt in Mineral Feed	$ 5.00
Zinc in Mineral Feed	$20.00
Nitrates and Nitrites	$ 3.00
Mold	$ 3.00
Nitrates, Nitrites and Mold (Combination)	$ 3.00
Silage or Haylage:	
Protein	$ 3.00
Moisture	$ 3.00

Jones (1965) of Alabama reports that their laboratory analyzes roughages for dry matter, crude protein and crude fiber only,

Table 2. List of States Having Feed Analytical Laboratories

State	Test Available	Operated By	Fee or Free
Alabama	Forage-Concentrates	Extension Service	Fee
Connecticut	Forage-Concentrates	Agriculture Experiment Station	Free
Georgia	Forage	Extension Service and Department of Agriculture	Free
Kentucky	Forage	Experiment Station	Fee
Lousiana	Forage	State University and Department of Agriculture	Free
Maryland	Forage	Extension Service	Fee
Massachusetts	Forage-Concentrates	State University	Free
North Carolina	Forage-Concentrates	N.C. State University and Department of Agriculture	Free
Oregon	Forage-Concentrates	Department of Agriculture Chemistry	Fee
Pennsylvania	Forage	Extension Service	Fee
South Dakota	Forage-Concentrates	Experiment Station and Biochemistry Department	Fee
Tennessee	Forage	Extension Service	Fee
Texas	Forage	Extension Service	Free
Utah	Forage-Concentrates	Utah State University	Free
Virginia	Forage	Extension Service	Free
Washington	Forage	Extension Service	Fee
West Virginia	Forage	Extension Service	Fee

whereas for concentrates the analysis includes ash, fat and nitrogen free extract as well as the above. The program is financed through a $5.00 per sample fee, and is self supporting.

Fisher (1965) of Connecticut states that their Experiment Station has been analyzing feeds since 1875 at no cost to farmers. This has not been a strain on their facilities because Connecticut is not primarily a farming State and the service has never been advertized and the demand has remained small.

Daniel (1965) reports Georgia to have a forage evaluation program. The samples go to the state chemist along with a sample identification sheet (Appendix A is for hay and Appendix B for silage). An information sheet (Appendix C) telling what the farmer wishes to feed the forage to and other feeds available to use in the ration goes to the Animal Husbandry office. When the chemists finish the analysis, the results are sent to the Animal Husbandry office to calculate the most practical and economical ration.

Mathews (1965) of Kentucky states they are analyzing samples of silage and hay for protein, fiber and moisture. The information is sent to the County Agent to figure out the amount of concentrates that are needed in the feed.

Epps (1965) of Louisiana reports that a forage quality program was begun a year ago. Samples of hay or silage are analyzed and given a quality rating.

Carson (1965) of Maryland states they have a forage evaluation program to provide a system for better evaluation of forages from which to make more valid feeding recommendations to livestock producers.

Colby (1965) of Massachusetts reports that feed is analyzed by the State at no expense to the farmer. He further stated that if a farmer used the service several times a year, there might be a cost involved.

Parsons (1965) of North Carolina stated that their laboratory was established in 1960. Their service includes both forages and concentrates and is available to the entire state's livestock industry. In 1964, a total of 1,117 samples were analyzed covering a total of 67 counties. He further stated that the county agricultural chairman is furnished the necessary forms - (Appendix-D, E and F) and supplies and supervises the actual taking of the sample during the initial stages of the program. Following analyses, the results are mailed directly to the farmer.

Hogan (1965) of Oregon reported that their Feed Analytical Service serves the general public through the offices of the county agents.

King (1965) of Pennsylvania states that they have a forage testing service but is essentially for forages and not feed grains. The price to farmers for this service is $5.00 per analysis.

Olson (1965) states that South Dakota has an analytical service since they do not have any commercial laboratories in the state. The fee schedule from South Dakota (Appendix G) is a representative sample from all states and lists charges for the analytical service.

Williams II (1965) of Tennessee reported that their forage testing service was initiated in July of this year. Williams II as the beef specialist, has prepared a number of rations that can be used in recommendations to beef cattlemen based on the amount

of protein in the forage.

Maddox, Jr. (1965) of Texas states they have a forage testing station, however, with several laboratories over the state, it is suggested that the feedlot operators take advantage of these commercial companies.

Mast (1965) reports that Virginia has a forage testing service with corn silage the most frequently tested followed by alfalfa hay and then the various clovers and grass silage. The state legislature appropriated money for setting up the laboratory and the Extension Service carries the operation as an item in their annual budget. The service costs the farmer nothing. All forage samples are sent through the county agent's office to the forage testing laboratory and the results are sent back through the county agent. The county agent makes appropriate comments on the analysis and forwards it on to the farmer. Mast also observed that the biggest benefit in a forage testing program, is the fact that livestock men are now making much better feed then they were when they started using the forage test. As an example, the average of all the corn silage tested the first year was 19.7 percent TDN and all samples tested last year or three years later averaged 22.8 percent TDN.

Kelso (1965) of Washington states that they initiated forage testing in 1960 which proved to make a greater awareness and appreciation of forage quality among livestock feeders. The forage samples submitted for analyses provided considerable educational information for evaluating the diversity of forage quality on a statewide basis. Kelso, further reports that inasmuch as there are now six commercial laboratories in the state offering forage

analyses service, the University laboratory was discontinued this year. More emphasis will be placed on education in the field and in working with these commercial laboratories.

Northern (1965) of West Virginia reports that they are making some major revisions in their program. The present analyse includes energy and protein. The results are sent to the farmer for forages sent to the laboratory.

Matthews (1965) of Utah states that research demands take first priority in the use of laboratory facilities, and therefore, results are rather slow in returning to the owners. This results in a commercial chemical service receiving most of the feed analysis work in the state.

Cunningham (1965) of Indiana reports that they plan to initiate a program within six months. Emphasis will be placed on protein and moisture determinations.

Variation in Nutrient Quality of Forages, Grains, and Supplements

Kelso et. al., (1962) shows the distribution in quality of forage samples tested in Washington (Appendix - H). The wide range in protein content points out the error of using average values of forages when balancing the protein level in grain mixtures.

Adams (1961) shows the range of crude protein (Appendix - I) and TDN (Appendix - J) after 2 years of forage testing in Pennsylvania. Adams further stated that these complicating factors make it rather difficult to pinpoint the amount of protein required in the grain mix with less complex methods than those used by the Pennsylvania forage testing service. The Pennsylvania study also revealed that Number 1 graded hays varied as much as 5 percent in

crude protein and 9 percent in TDN when trained individuals attempted to estimate nutrient content of forages.

Adams (1961) also illustrates the influence of date of cutting on TDN content of hay-crop forages (Appendix - K).

Seven different stages of maturity in harvesting oats for oat silage revealed a decrease in TDN according to Meyer et al; (1957). TDN in the oat forage decreased slowly from 68% in the jointing stage to 60% in the flower stage.

Feed Analytical Station

Benne (1965) developed minimum specifications (monetary and physical) for establishing and operating a feed analytical service for Michigan farmers. Inventory and operation budgets are shown in (Appendix - L). A lot would depend on the volume of work involved.

EXPERIMENTAL PROCEDURE

At the outset, the assumption was made that if a feed analytical service was to be of lasting value to Michigan cattle feeders, it must be of value to those feeders who are presently employing excellent management and are above average ability. Therefore, cattle feeders selected as cooperators in this study were in all cases considered to be among the best cattle feeders in the State of Michigan and recognized as such by their neighbors, county and state extension personnel and the Michigan Cattle Feeders Association.

Since the author was employed as Extension Agricultural Agent in Gratiot County, Michigan during the period of data collection, cattle feeders in Gratiot County were selected for convenience purposes.

In order to make valid comparisons between cattle feeders, all cooperators selected were following the same type of feeding program, utilizing similar feeds and feeding similar cattle. In all cases, each cooperator was attempting to follow a feeding program consisting of a full feed of corn silage plus 1% of body weight daily in concentrates.

Eight cattle feeders were selected for this study and each feedlot was visited unannounced once a month for sampling purposes, beginning in mid January 1965 and concluding in late June 1965.

Corn silage was sampled as it was removed from the silo and the complete ration was sampled after distribution in the feed bunk. Due to

physical limitations on the number of samples that could be analized, no analysis were made on the corn and protein supplement component of the ration.

Description of Feedlot Cooperators

Farm No. 1

a. Capacity - Approximately 325 head with 271 head on feed at the beginning of the sample period.

b. Cattle - Choice calves with 150 steers and 121 heifers averaging 425 pounds when purchased. The majority of the cattle had been on feed 100 days at the beginning of the sample period.

c. Feeding System - The cattle were fed from double sided feed bunks within the feedlot which were portable and filled twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - Three silos were utilized in storing corn silage - one 14' x 50', one 12' x 40' and the other 22' x 70'. All samples utilized in this study were taken from the 22' x 70' silo. All silage was treated with 10 pounds of feed grade urea and 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped fine and the silos filled before the first frost. Moisture averaged approximately 63% at the time of filling the silo. Silage yields were approximately 20 tons per acre and the estimated corn grain yield was 120 bushels per acre. At feeding time, the feed bunks were driven be-

neath the silo chute and filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the cattle would barely clean up between each feeding.

e. Corn - Dry corn and cob which was ground through a hammer mill as it came from the crib was fed the first four months of the sampling period. A combination of dry shelled corn and dry ear corn, also ground through a hammer mill, was included in the ration the last two months of the study. The corn was ground once a day and stored in a wagon. The corn was measured with a scoop shovel and the amount determined by the number of shovels placed uniformly over the top of the silage.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a volume basis and spread evenly in the feed bunk over the shelled corn.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were self fed throughout the testing period, in a two compartment mineral feeder. Neither ingredient was added to the ration.

h. Hay - One pound of second cutting alfalfa hay was fed per head daily. The hay was leafy with good quality and color.

Farm No. 2

a. Capacity - Approximately 700 head with 300 head on feed

at the beginning of the sample period.

b. Cattle - Good and Choice calves with 250 steers and 50 heifers averaging 580 pounds when purchased. The cattle had been on feed 120 days at the beginning of the sample period.

c. Feeding System - The cattle were fed with an auger feed bunk filled twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - One silo was utilized in storing corn silage - 20' x 70'. All silage was treated with 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped medium fine and the silo filled before the first frost. Moisture averaged approximately 63% at the time of filling the silo. Silage yields were approximately 20 tons per acre and the estimated corn grain yield was 120 bushels per acre. At feeding time, the auger was filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the feed bunk was cleaned up between each feeding.

e. Corn - Dry ear corn which was ground through a hammer mill as it came from the crib was utilized the first four months of the sampling period. A combination of ground shelled corn and ground wheat was included in the ration the last two months of the study. The corn was ground once a day and stored in a wagon. The amount fed was determined at each feeding on a volume displacement basis.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a timed protein meter and evenly spread throughout the auger.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were mixed together at the rate of 1:1 and self fed throughout the feeding period. Neither ingredient was added to the ration.

h. Hay - Two pounds of first cutting alfalfa and timothy hay was fed per head daily. The hay was average in quality, color and leafiness.

Farm No. 3

a. Capacity - Approximately 250 head with 221 head on feed at the beginning of the sample period.

b. Cattle - Choice calves with 96 heifers and 125 steers averaging 455 pounds when purchased. The majority of the cattle had been on feed 140 days at the beginning of the sample period.

c. Feeding System - The cattle were fed from a fence line feed bunk with a self-unloading wagon twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - One silo was utilized for storing corn silage - 20' x 60'. All silage was treated with 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped fine and the silo filled before the

first frost. Moisture averaged approximately 63% at the time of filling the silo. Silage yields were approximately 22 tons per acre and the estimated corn grain yield was 140 bushels per acre. At feeding time, the self-unloading wagon was driven beneath the silo chute and filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the cattle would barely clean up between each feeding.

e. Corn - High moisture ear corn, which was put through a recutter as the silo was filled was fed throughout the feeding period. The ear corn averaged approximately 25% moisture when stored in a 16' x 60' concrete stave silo. Corn was fed by having the silo unloader discharge the material directly into the self-unloading wagon after the required amount of silage had been added. This was uniformly spread over the top of the silage and the amount determined by the depth of the corn within the self-unloading wagon.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a volume basis and spread evenly in the self-unloading wagon over the shelled corn.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were mixed together at the rate of 1:1 and self fed throughout the feeding period. Neither ingredient was

added to the ration.

h. Hay - No hay was fed at any time during the sampling period.

Farm No. 4

a. Capacity - Over 600 head with 415 cattle on feed at the beginning of the sample period.

b. Cattle - Choice calves with 140 heifers and 275 steers averaging 365 pounds when purchased. The cattle had been on feed 90 days at the beginning of the sample period.

c. Feeding System - The cattle were fed with an auger feed bunk filled twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - Two silos were utilized in storing corn silage - one 30' x 70' and the other 20' x 65'. All samples in this study were taken from the 30' x 70' silo. All silage was treated with 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped fine and the silos filled before the first frost. Moisture averaged approximately 62% at the time of filling the silos. Silage yields were approximately 25 tons per acre and the estimated corn grain yield was 150 bushels per acre. At feeding time, the auger was filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the silage in the feed bunk was cleaned up between each feeding.

e. Corn - High moisture ground ear corn was fed throughout

the feeding period. The ear corn averaged 30% moisture when stored in a 20' x 65' concrete stave silo. Corn was fed by having the silo unloader discharge the material directly into the auger at the same time the silage was being discharged so that they were mixed together by the auger in the feed bunk. The amount fed was determined at each feeding on a volume displacement basis.

f. Protein Supplement - A 32% protein supplement made up 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a timed protein meter and evenly spread throughout the auger.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were mixed together at the rate of 1:1 and self fed throughout the feeding period. Neither ingredient was added to the ration.

h. Hay - No hay was fed at anytime during the sampling period.

Farm No. 5

a. Capacity - Approximately 700 head with 300 cattle on feed at the beginning of the sample period.

b. Cattle - Choice calves averaging 385 pounds when purchased. The entire lot of 300 were steers and had been on feed 123 days at the beginning of the sample period.

c. Feeding System - The cattle were fed from double sided feed bunks within the feedlot with a self-unloading wagon twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - Two silos and a stack were utilized for storing

corn silage - one 26' x 60', the other 20' x 70'. The stack was on the ground and completely covered with plastic. The first two months of the sampling period, silage was used from the stack on the ground and the remaining of the study, silage was taken from the 26' x 60' silo. All silage was treated with 10 pounds of limestone at the time of filling the silos. Silage was chopped fine and all silos filled before the first frost. Moisture averaged 62% in the stack and 68% in the upright silos at the time of filling. Silage yields were approximately 20 tons per acre and the estimated corn grain yield was 120 bushels per acre. At feeding time the self-unloading wagon was filled with a manure scoop the first two months and driven beneath the silo chute and filled directly from the silo for the last four months. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the cattle would barely clean up between each feeding.

e. Corn - High moisture ground shelled corn was utilized the first three months and dry ground shelled corn was utilized the last three months of the sampling period. The high moisture corn averaged approximately 30% moisture when stored in a 20' x 60' concrete stave silo. Corn was fed by having the unloader discharge the material directly into the self-unloading wagon after the required amount of silage had been added. This was uniformly spread over the top of the silage and the amount determined by the depth

of the corn within the self-unloading wagon. The dry shelled corn was handled the same way after being ground in a hammer mill and discharged into the self-unloading wagon.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a volume basis and spread evenly in the self-unloading wagon over the ground shelled corn.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were self fed throughout the testing period, in a two compartment mineral feeder. Neither ingredient was added to the ration.

h. Hay - 1½ pounds of good alfalfa hay was fed per head daily. The hay was leafy with good quality and color.

Farm No. 6

a. Capacity - Manages over 500 head with 186 cattle on feed at the beginning of the sample period.

b. Cattle - Choice calves with the group evenly divided between steers and heifers. The cattle weighed 350 pounds when purchased and had been on feed 81 days at the beginning of the sample period.

c. Feeding System - The cattle were fed from double sided feed bunks within the feedlot with a self-unloading wagon twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - Two silos were utilized for storing corn

silage - one 24' x 70', the other 20' x 60'. All samples utilized in this study were taken from the 24' x 70' silo. All silage was treated with 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped fine and the silos filled before the first frost. Moisture averaged 64% at the time of filling the silo. Silage yields were approximately 15 tons per acre and the estimated corn grain yield was 95 bushels per acre. At feeding time, the self-unloading wagon was driven beneath the silo chute and filled directly from the silo. The amounts fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetitie, such that the cattle would barely clean up between each feeding.

e. Corn - High moisture ground ear corn was utilized during the entire sampling period. The corn-cob meal averaged approximately 30% moisture when stored in a 20' x 60' concrete stave silo. Corn was fed with the silo unloader discharging the material directly into the self-unloading wagon after the required amount of silage had been placed in the wagon. This was uniformly spread over the top of the silage and the amount determined by the depth of the corn within the self-unloading wagon.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a volume basis and spread evenly in the self-

unloading wagon over the ground ear corn.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were mixed together at the rate of 1:1 and self fed throughout the feeding period. Neither ingredient was added to the ration.

h. Hay - 1½ pounds of fair quality second cutting alfalfa hay was fed per head daily. The hay had good color and was just average in leafiness.

Farm No. 7

a. Capacity - Approximately 600 head with 227 head on feed at the beginning of the sample period.

b. Cattle - Choice heifer calves averaging 350 pounds when purchased. The cattle had been on feed 153 days at the beginning of the sample period.

c. Feeding System - The heifers were fed from double sided feed bunks within the feedlot filled with a self-unloading wagon twice daily. No mixing or weighing equipment was used.

d. Corn Silage - One silo was utilized for storing corn silage - 26' x 60'. Silage was chopped medium fine and the silo filled before the first frost. Moisture averaged 68% at the time of filling the silo. Silage yields were approximately 18 tons per acre and the estimated corn grain yield was 105 bushels per acre. At feeding time, the self-unloading wagon was driven beneath the silo chute and filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage

was fed according to appetite, such that the cattle would barely clean up between each feeding.

e. Corn - High moisture ground ear corn was fed the first four months of the sampling period and dry ground shelled corn the last two months. The high moisture corn averaged 30% moisture when stored in a 20' x 60' concrete stave silo. Corn was fed by having the unloader discharge the material directly into the self-unloading wagon after the required amount of silage had been added. This was uniformly spread over the top of the silage and the amount determined by the depth of the corn within the self-unloading wagon. The dry shelled corn was handled the same way after being ground in a hammer mill and discharged into the self-unloading wagon.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a volume basis and spread evenly in the self-unloading wagon over the corn.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were self fed throughout the testing period, in a two compartment mineral feeder. Neither ingredient was added to the ration.

h. Hay - No dry hay was fed at anytime during the sampling period. However, direct cut aflalfa haylage was fed the last month of the study at the rate of 9 pounds per head daily,

once a day.

Farm No. 8

a. Capacity - 600 head with 480 head on feed at the beginning of the sample period.

b. Cattle - Choice spring calves with 200 heifers and 260 steers averaging 445 pounds when purchased. The majority of the cattle had been on feed 120 days at the beginning of the sample period.

c. Feeding System - The cattle were fed with an auger feed bunk filled twice daily. No mixing or weighing equipment was employed.

d. Corn Silage - Two silos were utilized in storing corn silage - both 24' x 70'. All silage was treated with 10 pounds of limestone per ton of silage at the time of filling the silo. Silage was chopped extra fine and the silos filled before the first frost. Moisture averaged approximately 62% at the time of filling the silos. Silage yields were approximately 25 tons per acre and the estimated corn grain yield was 150 bushels per acre. At feeding time, the auger was filled directly from the silo. The amount fed was determined at each feeding on a volume displacement basis. Silage was fed according to appetite, such that the silage in the feed bunk was cleaned up between each feeding.

e. Corn - High moisture shelled corn, which was put through a recutter as the silo was filled was fed throughout the feeding period. The shelled corn averaged approximately 30% moisture when stored in a 14' x 50' stave silo. Corn

was fed by having the silo unloader discharge the material directly into the auger at the same time the silage was being discharged so that they were mixed together by the auger in the feed bunk. The amount fed was determined at each feeding on a volume displacement basis.

f. Protein Supplement - A 32% protein supplement made up of 10% by weight of urea was fed throughout the sampling period. An attempt was made to feed 1½ pounds per head daily evenly split between the two feedings. This was measured on a protein timed meter and evenly spread throughout the auger.

g. Salt and Minerals - Trace mineralized salt and dicalcium phosphate were mixed together at the rate of 1:1 and self fed throughout the feeding period. Neither ingredient was added to the ration.

h. Hay - No hay was fed at anytime during the sampling period.

Field Procedure

Immediately upon arrival at each feedlot, the feed analysis survey form shown in Appendix M was filled out with the cooperation of the respective cattle feeder. Arrival at the feedlot was scheduled to coincide with either the morning or afternoon's feeding period. While silage was being removed from the silo, a total of 30 grab samples were taken and placed in a bushel container. The composite sample was thoroughly mixed and a sample of approximately one quart was taken from this. The sample was immediately placed in a sealed cellophane bag and appropriately identified. The complete ration sample was taken from the feed bunk after all cattle had been

fed. Again, a total of 30 grab samples were taken throughout the length of the feed bunk as described above. Within one hour after collecting the samples, both the silage and complete ration samples were placed in a freezer where they were held for later analyses. Samples were later transferred to the Biochemistry Laboratory, Michigan State University where laboratory analyses were conducted.

Laboratory Procedure

All samples were prepared and analyzed according to the official methods of analysis specified in the tenth edition (1965) of the Association of Official Agricultural Chemists.

In all cases, analytical values are the average of two paired samples.

Calculation Procedures

Standard deviations were computed for all analyses according to the methods of Snedecor (1956).

Nutrient requirements for feed lot cattle were taken from - Nutrient Requirements of Beef Cattle (1963). Publication 1137, National Academy of Science.

All calculated TDN values were arrived at by using average digestion coefficients for Fat, Fiber, NFE, and Crude Protein as shown in Morrison's Standards (1956) times the actual analysis of the sample in question.

RESULTS AND DISCUSSION

Proximate Analysis of Corn Silage

Complete results of all proximate analysis conducted on corn silage are shown in Tables 3 through 10.

Moisture: Average moisture levels for corn silage samples conducted on all farms by months are shown in Table 3. A high moisture value of 71.77% was obtained in January on Farm No. 5 and a low moisture value of 59.26% was obtained in April on Farm No. 8. Moisture values of 71.77% and 71.14% obtained on Farm No. 5 during January and February came from early cut silages stored in a stack and covered with a plastic sheet. The remaining values from Farm No. 5 and the other farms were obtained from later cut silages and stored in concrete stave silos. A great deal of variation in present moisture of corn silage existed from month to month on all farms. For example, Farm No. 7 varied from a high of 70.92% in March to a low of 61.42% in June and Farm No. 6 from a high of 69.65% in June to a low of 62.62% in January. These data clearly illustrate the high degree of inaccuracy involved when a single moisture determination is used to estimate the percent moisture of an entire silo.

In all cases the mean percent moisture value for each farm was considerably below that shown in Morrison's standards, thus indicating a possible trend toward harvesting more mature and dryer silages. Therefore, Morrison's standards were of little value in appraising the percent moisture of silages in question.

From these data, it appears necessary for cattle feeders to test their silages for moisture as frequently as once a month in order to properly balance rations for energy and other ration components.

Table 3: Percent Moisture of Corn Silage by Months and Farms

Farm No.	Month						
	Jan.	Feb.	Mar.	Apr.	May	June	Mean
1	65.35	65.82	66.77	71.06	69.80	67.29	67.68
2	61.66	60.64	60.90	63.22	61.38	56.95	60.79
3	67.63	68.19	66.66	66.00	64.18		66.53
4	64.30	61.73	59.38	62.79	62.88	66.93	63.00
5	71.77	71.14	60.63	65.46	64.82	63.87	66.28
6	62.62	63.13	63.80	68.87	66.35	69.65	65.73
7	69.32	68.87	70.92	67.58	62.05	61.42	66.69
8	63.31	64.34	65.06	59.26	64.46	61.93	63.06
Mean	65.75	65.48	64.27	65.53	64.49	64.01	64.95
Morrison's Standards							71.50

Standard Deviation of within farm mean = 2.92

Ash: Complete results of all analysis conducted for ash by months and by farms are shown in Table 4. Although ash plays a minor role in ration formulation, ash analysis were conducted in order to arrive at nitrogen-free extract values by difference. Although all silages were treated with ten pounds of ground limestone per ton of silage at the time of filling silos (with the exception of Farm No. 7) average ash values fell slightly below those reported in Morrison's standards which is assumed to be on silages not treated with limestone. The author is unable to ex-

plain this discrepancy.

Average ash values for Farm No. 7 were consistently below all other farms and was the only farm in this analysis that did not treat the silage with ground limestone at the time of filling the silo. A low ash value of 3.20% was obtained in May on Farm No. 7 and a high value of 8.67% was obtained in January on Farm No. 2. On an individual farm basis the percent ash varied as much as 100%, such as a high of 7.08% in January and a low of 3.20% in May for Farm No. 7 and a high of 8.67% in January and a low of 4.82% in June for Farm No. 2. This points out rather clearly that silages should be sampled as often as once monthly in order to arrive at ash values which have some meaning. If silages are not sampled as often as this, then it would appear that the average value quoted in Morrison's standards would, have more meaning and would be a more valid figure to use.

Crude Fiber: Results of crude fiber analysis on a dry matter basis by farms and by months are shown in Table 5. Again the overall mean for crude fiber does not differ substantially from that shown in Morrison's standards; however, the within-farm variation from one month to another amounted to as much as 20% as indicated in Farm No. 1 between the value of 18.69% in January and 23.28% in June; on Farm No. 4 with a low of 19.46% in March and a high of 24.61% in June; and on Farm No. 7 with a low of 16.25% in June and a high of 25.19% in March. Again as was the case with ash, it appears to be far better to use Morrison's standards than the results of a single sample, since the overall farm mean for the six sample months did not differ substantially from Morrison's standards,

whereas, individual samples varied considerably from the farm mean and also Morrison's standards.

Table 4: Percent Ash of Corn Silage on a Dry Matter Basis[1/]

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	6.03	5.60	5.05	6.02	6.67	5.06	5.73
2	8.67	5.60	5.84	5.62	5.99	4.82	6.09
3	6.50	5.81	6.03	4.55	5.09		5.60
4	5.36	4.75	4.22	4.81	5.85	5.60	5.10
5	6.01	6.09	6.27	7.08	6.47	4.50	6.07
6	5.85	4.63	4.99	5.60	5.33	5.74	5.36
7	7.08	3.23	3.84	3.60	3.20	3.39	4.06
8	7.41	7.36	5.80	6.44	6.44	5.21	6.44
Mean	6.61	5.39	5.26	5.47	5.63	4.90	5.56
	Morrison's Standards						5.61

Standard Deviation of within farm mean = .94

1/ All silage was treated with 10 lbs. limestone per ton of corn silage at the time of filling the silo with the exception of Farm No. 7.

Ether Extract: Average values for percent ether extract in corn silage on a dry matter basis by farms and months are shown in Table 6. A high value of 3.53% ether extract was obtained in May on Farm No. 1 and a low value of 2.09% in June on Farm No. 4. Farm No. 4 varied from a low of 2.09% in June to a high of 3.50% in January. Individual farm means as well as the overall mean for all farms do not differ substantially from Morrison's standards and thus appears to be a more acceptable value to use than any one single value obtained from analysis.

Table 5: Percent Crude Fiber of Corn Silage on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	18.69	20.00	21.42	21.87	21.79	23.28	21.18
2	25.38	20.99	20.74	19.43	19.76	17.27	20.60
3	21.61	21.57	21.57	18.87	21.26		20.98
4	19.69	21.22	19.46	21.49	24.55	24.61	21.84
5	22.16	23.82	19.20	23.37	21.25	19.39	21.53
6	23.95	21.32	24.08	21.15	19.22	21.37	21.85
7	22.69	23.94	25.19	24.77	17.73	16.25	21.76
8	19.67	17.36	22.31	19.27	21.62	20.48	20.12
Mean	21.73	21.28	21.75	21.28	20.90	20.38	21.23
Morrison's Standards							22.11

Standard Deviation of within farm mean = 2.30

Table 6: Percent Ether Extract of Corn Silage on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	3.45	3.51	3.46	3.42	3.53	2.64	3.33
2	2.26	2.71	3.03	3.09	3.14	3.12	2.89
3	2.90	3.03	3.07	3.38	3.06		3.09
4	3.50	2.34	2.85	2.85	2.69	2.09	2.72
5	3.16	2.72	2.46	2.56	2.63	2.62	2.69
6	2.78	2.66	2.61	2.84	3.30	3.33	2.92
7	3.37	2.85	3.34	3.24	3.63	3.44	3.31
8	3.16	2.89	2.28	2.33	3.06	2.51	2.71
Mean	3.07	2.84	2.89	2.98	3.13	2.82	2.96
Morrison's Standards							3.16

Standard Deviation of within farm mean = .33

Crude Protein: Complete results of crude protein analysis of corn silage on a dry matter basis by farms and months are shown in Table 7. It is interesting to note that in case of Farm No. 1 where ten pounds of 45% nitrogen-urea was added per ton of corn silage at the time of filling the silo, percent crude protein was increased approximately 50% over the value shown for the remaining seven farms. It is also interesting to note that the within-farm variation did not appear to excede that for the other farms where no urea was added, thus, indicating that a good job of mixing and distribution had been obtained. On a calculated basis, the amount of crude protein found is in agreement with the amount that should have been present if no loss of urea had occurred during the ensiling process, indicating a high level of recovery of the added urea.

Again as has been the case with other analysis conducted, the farm mean as well as the overall mean does not differ materially from the values shown in Morrison's standards. Again, as was the case with the other analysis conducted, within-farm variation was rather substantial with lows of approximately 7.5% and highs of approximately 9.5%. Again it appears far more desirable to use the average values found in Morrison's standards than the results of a single sample and if a superior value is to be obtained the corn silage would have to be sampled as often as once monthly.

No explanation can be offered for the high crude protein value obtained for Farm No. 8 in April. This again points out the fallacy of basing all feeding results on a single sample.

Table 7: Percent Crude Protein of Corn Silage on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1[1]	12.44	11.81	11.75	9.19	11.00	11.19	11.23
2	7.69	8.06	9.00	8.88	7.88	8.06	8.26
3	7.88	8.75	9.25	8.94	8.75		8.71
4	8.25	7.31	8.13	7.94	7.75	7.94	7.88
5	7.94	7.75	9.19	7.81	8.56	7.75	8.17
6	8.19	8.31	8.69	7.88	8.13	8.88	8.34
7	8.19	7.63	9.44	8.00	8.06	9.50	8.47
8	7.50	8.13	8.38	12.00	7.88	7.69	8.59
Mean[2]	7.95	7.99	8.87	8.78	8.14	8.30	8.34
Morrison's Standards							8.07

Standard Deviation of within farm mean = .87

1/ Urea added to silage at rate of 10 pounds per ton at the time of filling silo.

2/ Farm No. 1 values not used in computing mean.

Nitrogen-Free Extract: Complete results of all silage samples tested for nitrogen-free extract are shown in Table 8. It should be pointed out that nitrogen-free extract (NFE) was obtained by difference and that all accumulative errors in conducting all other analyses are represented in the NFE values.

Farm means as well as the overall mean did not differ substantially from the value shown in Morrison's standards. A high value of 67.42% for nitrogen-free extract was obtained in June on Farm No. 7 and a low value of 56.00% was obtained in January on Farm No. 2. Farm No. 2 varied from a low of 56.00% in January to

a high of 66.73% in June and Farm No. 7 varied from a low of 58.19% in March to a high of 67.42% in June; thus, indicating again that a single sample of corn silage does not give a very accurate picture of its NFE value and that values shown in Morrison's standards would be far better to use than the results of a single sample. Again it appears that corn silage should be sampled at least monthly to obtain a more valid value than Morrison's standards.

Table 8. Percent Nitrogen Free Extract of Corn Silage on a Dry Matter Basis

	Month						
Farm No.	Jan.	Feb.	Mar.	Apr.	May	June	Mean
1	59.39	59.08	58.32	59.50	57.01	57.83	58.53
2	56.00	62.64	61.39	62.98	63.23	66.73	62.16
3	61.11	60.84	60.08	64.26	61.84		61.62
4	63.20	64.38	65.34	62.91	59.16	59.76	62.46
5	60.73	59.62	62.88	59.18	61.09	65.74	61.54
6	59.23	63.08	59.63	62.53	64.02	60.68	61.53
7	58.67	62.35	58.19	60.39	67.38	67.42	62.40
8	62.26	64.26	61.23	59.96	61.00	64.11	62.14
Mean	60.08	62.03	61.13	60.22	61.84	63.18	61.54
Morrison's Standards							61.06

Standard Deviation of within farm mean = 2.57

Calculated Total Digestible Nutrients: Using average digestion coefficients taken from Morrison's standards for crude fiber, ether extract, crude protein, and NFE; values for total digestible nutrients (TDN) have been computed for each corn silage sample taken by

farms and by months and the results are shown in Table 9. As has been the case previously, mean values for each farm and the overall mean does not differ substantially from the values shown in Morrison's standards and thus appears to be quite an acceptable value to use. It is a far better estimate than that obtained from a single sample taken on corn silage as indicated by the amount of variation from month to month within individual farms.

Table 9. Calculated T.D.N. Values of Corn Silage on a Dry Matter Basis[1/]

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	68.81	69.18	69.40	69.09	68.38	68.48	68.89
2	65.88	68.98	68.97	69.35	69.29	70.34	68.80
3	68.48	68.96	68.74	70.48	68.55		69.24
4	70.05	69.35	70.28	69.67	68.47	68.01	69.30
5	69.04	68.40	68.19	67.54	68.13	69.92	68.53
6	68.55	69.57	68.90	69.13	69.93	69.31	69.23
7	68.35	70.66	70.24	70.63	72.01	71.55	70.57
8	68.33	68.20	68.20	67.39	68.69	69.19	68.33
Mean	68.44	69.16	69.11	69.16	69.31	69.54	69.11
Morrison's Standards							69.47

Standard Deviation of within farm mean = .93

1/ Digestion Coefficients taken from Morrison's Standards.

Summary of All Means: Table 10 gives a summary of all farm means for the six sample months of all anlaysis conducted. It is interesting to note that on a dry matter basis the farm mean as well as the overall mean for each analysis does not differ substantially

Table 10. Summary of Means for All Analysis of Corn Silage (all values expressed on a dry matter basis with the exception of moisture)

Farm No.	Ash	Crude Fiber	Ether Extract	Crude Protein	Nitrogen Free Extract	Calculated TDN	Moisture
1	5.73	21.18	3.33	11.23	58.53	68.89	67.68
2	6.09	20.60	2.89	8.26	62.16	68.80	60.79
3	5.60	20.98	3.09	8.71	61.62	69.24	66.53
4	5.10	21.84	2.72	7.88	62.46	69.30	63.00
5	6.07	21.53	2.69	8.17	61.54	68.53	66.28
6	5.36	21.85	2.92	8.34	61.53	69.23	65.73
7	4.06	21.76	3.31	8.47	62.40	70.57	66.69
8	6.44	20.12	2.71	8.59	62.14	68.33	63.06
Mean	5.56	21.23	2.96	8.34[1/]	61.54	69.11	64.95
Morrison's Standards	5.61	22.11	3.16	8.07	61.06	69.47	71.50
Percent Variation from Morrison's Standards	-.89	-3.98	-6.33	+3.35	+ .79	- .52	-9.16

1/ Farm No. 1 not used in mean

from values shown in Morrison's standards with the exception of moisture. Thus, these data point out rather clearly that if the dry matter content of a silage is known, average values shown in Morrison's standards would be essentially as accurate as a

series of six samples taken of the silage in question. As pointed out previously, it would be far more accurate than the results of a single sample. Thus, based on these data, testing corn silage for ash, crude fiber, ether extract, crude protein, and nitrogen-free extract is not warranted and that the values obtained would be of little value in reducing overall ration costs and improving efficiency.

These data do point out rather clearly, however, that corn silages does vary rather substantially from farm to farm with respect to percent moisture and this value must be known before Morrison's standards can be related to a particular silage in question.

Proximate Analysis of Complete Ration

Results of all proximate analysis conducted on complete ration are shown in Tables 11 through 18.

Moisture: Average moisture levels for complete ration samples conducted on all farms by months are shown in Table 11. A great deal of variation in percent moisture of complete ration existed from month to month on all farms. For example, Farm No. 3 varied from a high of 63.72% in April to a low of 12.25% in June, Farm No. 5 from a high of 63.45% in February to a low of 20.48% in June and Farm No. 7 reaching a high of 51.47% in January and dropping to a low of 23.59% in June. These datas clearly illustrates the high degree of inaccuracy involved when a single moisture determination is used to estimate the percent moisture

of the complete ration over a period of time. The mean value for all farms by months decreased as the study progressed from January to June.

This would indicate that drying was taking place in the silo as the weather warmed up or the percent concentrates in the ration was being increased as the feeding period progressed or a combination of both factors. Based on these data, it appears necessary for cattle feeders to test the complete ration for moisture as frequently as once a month in order to accurately know the dry matter intake of their cattle.

Ash: Complete results of all analysis conducted for ash by months and by farms are shown in Table 12. A high value of 5.79% was obtained in January on Farm No. 8 and a low value of 2.52% was obtained in March on Farm No. 7. Individual farms varied from month to month from a high of 5.79% in January to a low of 3.50% in April for Farm No. 8 and for Farm No. 5 from a high of 4.84% in February to a low of 2.97% in June. Even though ash plays a minor role in ration formulation, it is interesting to note that Farm No. 7 was consistently below all other farms and was the only farm in this analysis that did not treat silage with ground limestone at the time of filling the silo. It appears rather closely that complete rations should be sampled as often as once monthly in order to arrive at ash values which have some meaning.

Table 11. Percent Moisture of Complete Ration by Months and Farms[1/]

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	42.32	56.63	58.27	58.79	49.58	49.65	52.54
2	37.95	38.61	37.54	31.24	44.81	29.50	36.61
3	50.19	57.18	52.19	63.72	35.80	12.25	45.22
4	61.62	52.73	49.17	45.09	46.62	51.54	51.13
5	59.56	63.45	49.61	41.96	41.38	20.48	46.07
6	42.84	49.09	40.90	49.88	47.37	36.18	44.37
7	51.47	53.41	49.97	44.05	31.04	23.59	42.65
8	55.08	51.07	48.71	45.22	41.86	37.20	46.52
Mean	50.13	52.77	48.30	47.49	42.31	32.59	45.62

Standard Deviation of within farm mean = 10.67

1/ See pages 12-25 for formulas of rations fed.

Note: All rations were composed of full feed corn silage plus 1% of body weight in concentrates.

Crude Fiber: Results of crude fiber analysis on a dry matter basis by farms and by months are shown in Table 13. The within farm variation from one month to another amounted to as much as 400% as indicated by Farm No. 3 with a high of 14.91% in February and a low of 2.70% in June and Farm No. 5 with a high of 13.86% in February and a low of 3.63% in June. It seems evident that each of these two farms consistently fed a smaller percentage of corn silage in their complete ration as the study progressed from January to June. It is evident from these data that a single sample is of little value in appraising the true crude fiber value of the complete ration.

Table 12. Percent Ash of Complete Ration on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	3.62	4.47	4.52	4.75	4.59	4.67	4.44
2	3.59	3.01	3.18	2.76	4.20	3.17	3.32
3	3.94	4.31	4.14	2.68	3.03	4.40	3.75
4	5.23	4.54	4.17	3.88	4.54	4.63	4.50
5	4.48	4.84	4.25	3.69	3.21	2.97	3.91
6	3.49	3.19	3.25	3.95	3.20	2.66	3.29
7	3.47	3.18	2.52	3.00	2.62	3.40	3.03
8	5.79	5.42	4.01	3.50	3.47	4.33	4.42
Mean	4.20	4.12	3.76	3.53	3.61	3.78	3.83

Standard Deviation of within farm mean = .61

Table 13. Percent Crude Fiber of Complete Ration on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	9.05	14.98	17.49	18.38	14.12	15.36	14.90
2	9.52	11.58	11.30	11.81	9.85	6.81	10.15
3	12.48	14.91	13.82	11.93	7.08	2.70	10.49
4	15.38	15.67	12.91	13.02	13.75	12.65	13.90
5	11.97	13.86	9.81	10.83	7.53	3.63	9.60
6	10.67	12.89	9.26	10.72	9.98	11.30	10.80
7	10.97	12.43	9.39	13.25	6.07	11.04	10.53
8	11.84	10.52	10.08	9.67	9.06	8.88	10.01
Mean	11.49	13.36	11.76	12.45	9.68	9.05	11.30

Standard Deviation of within farm mean = 2.74

Ether Extract: Average values for percent ether extract in complete ration on a dry matter basis by farms and months are shown in Table 14. A high value of 3.97% was obtained in May on Farm No. 3 and a low value of 1.57% was obtained in April on Farm No. 2. Within farm samples varied from a high of 3.52% in February to a low of 1.57% in April on Farm No. 2 and a high of 3.97% in May to a low of 1.60% in June on Farm No. 3. It appears evident that monthly samples of the complete ration would have to be taken to arrive at ether extract values which have some meaning.

Table 14. Percent Ether Extract of Complete Ration on a Dry Matter Basis

	Month						
Farm No.	Jan.	Feb.	Mar.	Apr.	May	June	Mean
1	3.56	3.79	3.52	2.95	3.84	3.31	3.49
2	3.19	3.52	2.31	1.57	3.04	2.22	2.64
3	3.20	3.66	2.94	2.98	3.97	1.60	3.06
4	3.31	3.25	3.12	3.09	3.13	2.87	3.13
5	3.47	3.53	2.11	2.36	2.46	2.22	2.69
6	3.00	3.52	3.10	3.11	3.62	2.79	3.19
7	3.31	3.47	3.53	3.04	3.67	3.77	3.47
8	2.88	3.44	2.26	3.18	3.57	2.47	2.97
Mean	3.24	3.52	2.86	2.79	3.41	2.66	3.08

Standard Deviation of within farm mean = .52

Crude Protein: Results of crude protein analysis of complete ration on a dry matter basis by farms and months are shown in Table 15. The high crude protein value of 15.44 was obtained on Farm No. 1 in January and the low value of 9.81% was obtained on

Farm No. 4 in February. The within farm variation was rather substantial as Farm No. 1 varied from a high of 15.44% in January to a low of 10.81% in April and Farm No. 6 varied from a high of 12.88% in March to a low of 9.88% in May. All of the farms varied by approximately 20% in crude protein values during the study indicating that monthly samples would have to be taken in order to obtain a usuable esitmate of crude protein.

Table 15. Percent Crude Protein of Complete Ration on a Dry Matter Basis

	Month						
Farm No.	Jan.	Feb.	Mar.	Apr.	May	June	Mean
1	15.44	12.63	12.50	10.81	12.56	12.88	12.80
2	13.00	11.00	11.50	11.13	12.88	12.75	12.04
3	10.88	10.56	10.38	10.56	12.31	12.25	11.16
4	10.31	9.81	11.25	11.25	10.44	10.25	10.55
5	10.94	10.13	11.81	11.75	11.31	13.94	11.65
6	11.81	9.94	12.88	11.81	9.88	10.25	11.10
7	12.94	10.88	12.13	11.81	12.75	12.00	12.08
8	10.81	10.88	11.31	10.81	15.56	12.38	11.96
Mean	12.02	10.73	11.72	11.24	12.81	12.09	11.67

Standard Deviation of within farm mean = 1.20

Nitrogen-Free Extract: Results of all complete ration samples tested for nitrogen-free extract are shown in Table 16. Nitrogen-free extract (NFE) values were obtained by difference and that all accumulative errors in conducting all other analysis are represented in the NFE values. The high NFE value of 79.05% was obtained on Farm No. 3 in June and the low value of 61.97% was obtained on Farm

No. 1 in March. Within farm samples varied month to month on Farm No. 3 from a high of 70.05% in June to a low of 66.56% in February and Farm No. 5 from a high of 77.24% in June to a low of 67.64% in February; thus, indicating again that a single sample of the complete ration does not give a very accurate picture of its NFE value.

Table 16. Percent Nitrogen Free Extract of Complete Ration on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	68.33	64.13	61.97	63.11	64.89	63.78	64.37
2	70.70	70.89	71.71	72.73	70.03	75.05	71.85
3	69.50	66.56	68.72	71.85	73.61	79.05	71.54
4	65.77	66.73	68.55	68.76	68.14	69.60	67.92
5	69.14	67.64	72.02	71.37	75.49	77.24	72.15
6	71.03	70.46	71.51	70.41	73.32	73.00	71.62
7	69.31	70.04	72.43	68.90	74.89	69.79	70.89
8	68.68	69.74	72.34	72.84	68.34	71.94	70.64
Mean	69.06	68.28	69.78	70.00	71.09	72.43	70.12

Standard Deviation of within farm mean = 2.60

Calculated Total Digestible Nutrients: Using Morrison's standards for average digestion coefficients for crude fiber, ether extract, crude protein and NFE, total digestible nutrient (TDN) values have been computed for each complete ration sample taken by farms and by months and the results are shown in Table 17. Little variation existed between the mean values for each farm and the overall mean. There was actually less variation from month to month

within farms for TDN than for any of the individual proximate analysis conducted.

Table 17. Calculated TDN of Complete Ration on a Dry Matter Basis

Farm No.	Month						Mean
	Jan.	Feb.	Mar.	Apr.	May	June	
1	80.16	78.85	78.03	77.36	78.98	78.34	78.62
2	80.10	80.77	79.45	79.04	79.39	80.13	79.81
3	79.51	79.18	78.89	80.52	81.93	79.44	79.91
4	78.01	78.54	79.09	79.28	78.74	78.67	78.72
5	79.42	78.89	78.63	79.13	80.39	80.79	79.54
6	79.94	80.50	80.37	79.65	81.21	79.92	80.26
7	80.02	80.42	81.48	79.84	82.14	80.64	80.76
8	77.57	78.91	78.99	80.46	80.27	79.01	79.20
Mean	79.34	79.51	79.36	79.41	80.38	79.62	79.60

Standard Deviation of within farm mean = .77

Summary of All Means: Table 18 gives a summary of all farm means for the six sample months of all analysis conducted.

Total Digestible Nutrient and Crude Protein Requirements vs Calculated Amounts Fed

Complete results of Total Digestible Nutrient (TDN) and crude protein required compared to calculated amounts fed are shown in Table 19. The percent crude protein and TDN calculated on individual farms was based on the proximate analysis. The required amounts of crude protein and TDN were taken from Nutrient Requirement of Beef Cattle. (National Academy of Sciences - National Research Council Publication 1137).

Table 18. Summary of All Means for All Analysis of Complete Ration (all values expressed on a dry matter basis with the exception of moisture)

Farm No.	Ash	Crude Fiber	Ether Extract	Crude Protein	Nitrogen Free Extract	Calculated TDN	Moisture
1	4.44	14.90	3.49	12.80	64.37	78.62	52.54
2	3.32	10.15	2.64	12.04	71.85	79.81	36.61
3	3.75	10.49	3.06	11.16	71.54	79.91	45.22
4	4.50	13.90	3.13	10.55	67.92	78.72	51.13
5	3.91	9.60	2.69	11.65	72.15	79.54	46.07
6	3.29	10.80	3.19	11.10	71.62	80.26	44.37
7	3.03	10.53	3.47	12.08	70.89	80.76	42.65
8	4.42	10.01	2.97	11.96	70.64	79.20	46.52
Mean	3.83	11.30	3.08	11.67	70.12	79.60	45.62

The mean value of percent crude protein of all farms was approximately 5 percent greater than the NRC standards for all farms. On individual farm basis, Farm No. 1 fed 15 percent more crude protein and Farm No. 4, 5 percent less crude protein than the NRC standards. With the exception of Farm No. 1, little difference existed between the percent crude protein mean value on individual farms and the NRC standards.

The mean value of percent TDN was greater than NRC standards on all farms. As indicated in procedures, each farm was attempting to follow a feeding program consisting of a full feed of corn silage and one percent of body weight daily in concentrates. In this case, percent TDN in the ration would vary from a low of approximately 75% TDN on a dry matter basis, when the cattle weigh

around 600 pounds and a high of approximately 79% TDN when the cattle reach 1000 pounds. From these data, it would appear that each farm was feeding slightly more than one percent of body weight daily in concentrates.

Table 19. Total Digestible Nutrient and Crude Protein Requirements vs Calculated Amounts Fed (Expressed on a Dry Matter Basis)

Farm Number	Percent Crude Protein[1/]	Percent TDN[1/]
1	12.80	78.62
2	12.04	79.81
3	11.16	79.91
4	10.55	78.72
5	11.65	79.54
6	11.10	80.26
7	12.08	80.76
8	11.96	79.20
Mean	11.67	79.60
NRC Standards	11.11	73.33

1/ Based on the Proximate Analysis

SUMMARY AND CONCLUSIONS

A field study was conducted in Gratiot County, Michigan, between January and June, 1965, to determine the value of conducting proximate analyses of corn silage and the complete ration being fed feedlot cattle by a selected group of eight cattle feeders. Each feedlot was visited unannounced once each month and samples of corn silage and the complete ration were taken. Samples were sealed in an airtight container, frozen and transferred to the Biochemistry Laboratory at Michigan State University for proximate analyses. All results are based on duplicate samples analyzed according to the methods outlined in the Tenth Edition of the Association of Agricultural Chemists.

Based on data presented, the following general conclusions may be drawn.

1. A great deal of variation existed from month to month within and between farms for percent moisture in corn silage and the complete ration. Therefore, corn silage and other high moisture feed ingredients must be analyzed for moisture as frequently as once a month in order to know with any degree of accuracy the dry matter content of ingredients being fed.

2. Likewise, an equal amount of variation existed from month to month within and between farms for percent ash, percent crude fiber, percent ether extract, percent crude protein, percent nitrogen free extract, and percent total digestible nutrients on a calculated basis. However, the mean value for all six samples for each analysis conducted for each farm did not vary substantial-

ly from values shown in Morrison's standards. Thus, it appears that values shown in Morrison's standards are equally acceptable to the mean value of six samples conducted and is a far better estimate than any one single sample conducted.

3. Based on the results of this study, the establishment of a feed analytical service for Michigan cattle feeders is not warranted at the present time.

Based on the above conclusions, the following general recommendations may be made. Cattle feeders utilizing silages and other high moisture ingredients to formulate their rations should test for dry matter as frequently as once per month. By using dry matter values in combination with Morrison's published average analyses standards, proximate analyses of the corn silage sample in question may be calculated and feeding programs and supplements adjusted accordingly.

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APPENDICES

APPENDIX - A

GA.FT-1

GEORGIA FORAGE TESTING PROGRAM
SAMPLE IDENTIFICATION

Name_____Sample No._____
Address_____County_____
Date of Sampling_____Type of Forage (Hay or Silage)_____
Submitted by_____
Have you used this service before? Yes_____; No_____.
Main Livestock Enterprise (check): Dairy_____; Beef_____;
Sheep_____; Swine_____; Other_____.
Was Penn State Sampler used in taking hay sample?_____

NOTE TO LABORATORY: Please enclose this form with laboratory report sent to Extension Dairyman, Athens, Georgia.

HAY INFORMATION

Crop(s)_____; Variety(ies)_____;
% of each _____Date cut_____.
Stage at cutting (check):
Before bloom_____; Early bloom_____; Headed_____;
Milk_____; Dough_____; Grain_____;
Curing Method (check):
Swath_____; Windrow_____; Forced Air_____; Heat & Air____;
Hay conditioner used: Yes_____; No_____.
Odor (check):
Clean hay smell_____; Weedy_____; Musty_____; Other_____.
Color (check):
Bright natural green____; Brownish green____; Bleached____.
Cutting (check): 1st_____: 2nd_____; 3rd_____.
For Coastal Bermuda grass, except for 1st cutting* - Days since last cut_____.
Fertilization (this year):
Mixed Goods per Acre: Pounds_____; Analysis_____;
Month Applied_____.
Pounds Actual Nitrogen per Acre_____; applied_____ days after cutting.
Estimated Yield per Acre_____tons. Rained on: Yes_____; No_____.
*First cutting of Coastal Bermuda grass should be made when plants are 12-15 inches in height.

* THIS SHEET MUST BE MAILED WITH SAMPLE *

APPENDIX - B

SILAGE INFORMATION

Crop(s)_____Variety(ies)_____
% of each_____Date cut_____
Stage at cutting (check):
Early dent_____; Dent_____; Hard dent_____; Pre-boot__;
Boot_____; Milk_____; Dough_____; Pre-bloom_____;
Early bloom_____; Full bloom_____; Past bloom_____.
Cutting method (check):
Direct cut_____; Wilted_____.

Type of Forage Harvester Used (check):

1. Conventional Forage Harvester
   If so, Type of Header Used (check):
   ____ Row Crop Header
   ____ Grass Header
   ____ Pickup Header

2. Flail Type Harvester
3. Rotary Mower Type Harvester
4. Other (specify):

Row spacing_____Seeding rate_____

Preservative used: Yes_____; No_____.
Kind of perservative_____; Amt. per ton_____lbs.
No. days required to fill silo_____.
Packing method: Tramped_____; Tractor_____.

Type of silo (check):
Upright_____
Bunker_____Covered: Yes_____; No_____.
Trench_____Covered: Yes_____; No_____.

Odor (check):
Clean, pleasant____; Burnt____; Yeasty or musty____; Putrid ___.

Color (check)
Light to dark green___; Yellowish green___; Black or brown_____.
Fertilization: Mixed goods per acre at seeding: Pounds_____;
Analysis_____; Pounds actual nitrogen per acre_____.
Estimated Yield per Acre_____tons.

* THIS SHEET MUST BE MAILED WITH SAMPLE *

APPENDIX - C

GEORGIA FORAGE TESTING PROGRAM

REQUEST FOR LIVESTOCK FEEDING PROGRAM

(Instructions: Please print or type. Mail completed form to Extension Dairyman, Athens, Georgia.)

Name_____ Date_____
R.F.D. or Street_____ County_____
Post Office _____

Check one: First Request_____ Repeat Request_____

NOTE: A COMPLETE FEEDING PROGRAM CAN ONLY BE DEVELOPED WHEN ALL NECESSARY INFORMATION IS FURNISHED AND SAMPLES OF ALL ROUGHAGE FED HAVE BEEN ANALYZED.

How much of the following roughages that have been analyzed do you have available for feeding?

Roughage	Sample No.*	Tons Available
_____	_____	_____
_____	_____	_____
_____	_____	_____

*Insert Sample No. that appears on Sample Identification Sheet, FT-1

BEEF CATTLE

Slaughter Cattle

1. Number of cattle to be fed_____
2. Approximate average weight of cattle now_____
3. Average age of cattle_____
4. Grade of cattle (Fancy, Choice, Good, Medium, Common)_____
5. Is there a desired month when you wish to market these cattle?
   _____
6. Do you plan to utilize spring and summer pasture?_____
7. Is pasture: Excellent____; Good____; Fair____; Poor_____
8. To what slaughter grade would you like to market these cattle? (Prime, Choice, Good, Standard, Utility)_____
9. About how much of the following home-grown grain do you have available to feed the above cattle:

   Corn & Cob Meal_____ Oats_____
   Shelled Corn _____ Other_____
   Barley _____

10. Are you prepared to purchase additional grain if necessary?
    _____

APPENDIX - D

FORAGE AND GRAIN TESTING PROGRAM

NORTH CAROLINA STATE

AND

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

COOPERATING

OPERATING PROCEDURE

1. Each sample must be accompanied by three copies of Form FA-1, "Forage and Grain Testing Information Sheet." The section applying to the sample being submitted must be filled out completely.

2. Follow Form FA-2, "Sampling and Mailing Instructions" in collecting the samples. In the beginning, the agent or his assistant should supervise the taking of the samples. Be sure to enclose a letter of transmittal.

3. Do not submit more than 15-20 samples during any one week. The facilities of the laboratory will be overloaded and delays will result.

4. Do not submit grain samples if protein supplements have been added.

5. It is doubtful if it will pay to sample batches of feed that are expected to last for less than one month.

6. Samples of hay and individual grains can be sampled before the actual feeding is begun if they are accessible.

7. Results will usually be available in 10-14 days after the samples have been received at the laboratory. Remember they are closed on Saturdays and certain holidays.

8. Results of the analysis will be filled in at the bottom of Form FA-1. Copies will be sent to both the farmer and the county extension chairman.

9. In addition to his results, the farmer will receive material instructing him how to apply the information to his own feeding program. For dairymen this will be a bulletin "Feeding Grain To Dairy Cows" written especially for use with the chemical forage analysis. For other classes of livestock, a letter from the appropriate specialist will follow.

10. The agent should check with the farmer to be sure he can interpret and apply this information. Keep in mind that unless he is keeping some type of animal performance records this information will be of little value to him.

FA-3

APPENDIX - E

FORAGE AND GRAIN TESTING PROGRAM

NORTH CAROLINA STATE COLLEGE

AND

NORTH CAROLINA DEPARTMENT OF AGRICULTURE

COOPERATING

SAMPLING AND MAILING INSTRUCTIONS

A forage or grain test is no better than the sample submitted. In order to gain the greatest benefit from this program, samples should be obtained according to the directions below so that they will represent the forage or grain being fed. Whenever a change is observed or suspected in the quality or type of forage fed, the forage should be tested immediately.

1. HAY

All samples of hay tested by the laboratory must be obtained by using the Penn State or similar type Forage Sampler, available from your County Agent.

A. Baled Hay

Sample at least 12 bales at random from the same lot of hay by taking core samples from the end of the bales. The weight of the core sample will vary directly with the tightness of the bale. In loosely baled hay, to obtain the desired quantity of sample, use the sampler to its full depth, while in tightly baled hay, use the sampler to only one-half its full depth.

B. Loose Long Hay and Chopped Hay

Sample to the full depth of the core sampler from at least 12 random locations throughout the mow. With the sampler in the vertical position, take the core sample at the spot where the hay is slightly compressed due to the weight of the person operating the sampler.

2. SILAGE

Obtain about one bushel of silage by collecting a double handful from at least 12 random locations over the entire exposed surface of the silage. Mix thoroughly in a clean bucket and take enough of the material to fill completely the container to be sent to the laboratory. When mechanical unloaders are

used take about one bushel of silage as it is fed. Do not take a sample from the first three feet of an upright or the very end of a horizontal silo.

3. GRAIN

   Select small samples from several bags, or areas of bin if stored in bulk, using a grain sampling tube if available. Mix the samples completely in a clean bucket and select a composite sample for analysis. No grain samples will be accepted where protein supplements have been added.

4. Fill in the information requested on Information Sheet FA-1 in triplicate and place all three copies inside the heavy paper bag. These must accompany the sample when mailed to the laboratory. Do not insert them in the plastic bag.

5. Pack each sample of hay, grain or silage in a separate plastic bag and seal air tight with a rubber band. Insert the plastic bag inside the heavy insulated paper bag, seal with staples or tape and mail immediately. Be sure to enclose county agents letter of transmittal.

6. Results of the analysis will usually be mailed to you in about 10-14 days after the sample has been received at the laboratory.

APPENDIX - F

FORAGE AND GRAIN TESTING INFORMATION SHEET

North Carolina Cooperative Agricultural Extension Service
Departments of Extension Dairy Husbandry and Agronomy Cooperating

Name_____Address_____County_____Date_____
Feed will be fed to: Dairy Cattle_____Beef_____
Sheep_____Poultry_____

Complete in triplicate only the section below that applies to this sample.

HAY Kind:_____Variety(ies)_____% of each_____
Fertilization (this year): Total N_____P_2O_5_____
K_2O_____ Date of Harvest_____

*Stage of Growth at Cutting: 1. Before head or bloom_____
2. Boot or Early bloom_____ 3. Headed or Full bloom_____
_____ 4. Milk or Dough_____ 5. Grain or Seed_____

Hay Making Method: Crushed or Crimped_____ Baled_____
Loose_____ Rained on: Yes_____ No_____

Curing Method: Swath_____ Windrow_____ Forced Air_____
Heat and Air_____

Color: Bright natural green_____ Brownish green_____
Faded, bleach_____ Moldy_____

Odor: Clean pleasant hay smell_____ Weedy_____
Musty_____ Other _____

Your description of Hay Quality: Excellent_____ Good_____
Fair _____ Poor _____

SILAGE Kind:_____ Variety(ies)_____% of each_____

Fertilization (at seeding and top-or sidedressing) Total N_____
_____ P_2O_5_____K_2O_____

**Stage of Growth at Cutting: Corn-1. Tasseled_____
2. Milk_____ 3. Early Dent_____ 4. Hard Dent_____
5. Ripe_____

Sorghum-1. Before Head_____ 2. Boot_____ 3. Head_____
4. Milk or Soft Dough_____ 5. Ripe_____

Grass or Legume-1. Before head or bloom_____ 2. Boot or early bloom_____ 3. Headed or full bloom_____
4. Milk or Dough _____ 5. Grain or Seed_____
Date of Harvest:_____ Cutting Method: Direct Cut_____
Wilted_____ Est. Yield per acre_____

Preservative used: Yes_____ No _____ Kind_____
Amount per ton _____ Water added_____

Packing Method: Tramped_____ Tractor_____
Rate of Fill: _____(Tons-Day)

Color: Light to dark green_____ Yellowish Green_____
Brown or Black _____

Odor: Clean, Pleasant_____ Yeasty or Musty_____
Burnt_____ Putrid_____

Type of Silo: Upright_____ Bunker_____ Trench_____
Cover: Yes_____ No_____ Type_____

Your description of Silage: Excellent _____ Good_____
Fair_____ Poor_____

HOME GROWN GRAIN Kind: _____ Variety(ies)_____
% of each_____

Fertilization: (at seeding and top-or sidedressing)
Total N_____ P_2O_5_____ K_2O_____

For Laboratory Use Only Sample No._____

RESULTS OF CHEMICAL ANALYSIS

Kind of Feed: _____	% on Moisture Free Basis	% As Fed
Moisture		
Crude Protein	_____	_____
Est. Digestible Proteins	_____	_____
Crude Fiber	_____	_____
Est. Total Digestible Nutrients	_____	_____
Est. Net Energy	_____	_____
Forage Quality***	_____	_____

FA-1

APPENDIX - G

FEED ANALYSES

The following analyses are made at this laboratory on feeds. Others may be made if we feel they are necessary or if circumstances require them and our facilities permit them.

Analysis	Charge
Proximate or "complete" analysis (includes moisture, protein, ether extract, crude fiber, ash and nitrogen-free extract)	$ 6.00
Moisture	.50
Ash	.75
Ether Extract (requires moisture determination)	1.50
Crude Fiber (requires moisture and ether extract determinations)	2.25
Crude Protein	1.00
Nitrogen-Free Extract (requires proximate analysis)	6.00
Calcium	2.50
Phosphorus	2.50
Carotene*	3.00
Salt (based on inorganic chlorides)	2.50
pH (silage only)	1.00
Urea	2.00
Extra handling charge for silage, green forage, or high-moisture grain	1.00

* Carotene is not vitamin A, but it is converted by the animal into vitamin A. Vitamin A as such does not occur naturally in feeds, and it is not analyzed for at this laboratory. While it is added to commercial feeds, such factors as its stability, the methods of incorporation, and the great amount of care necessary to make sure of the accuracy of the determination of vitamin A in these feeds, plus the fact that the amount will be declared on the label, make its determination difficult to justify.

NOTE: Total digestible nutrients (TDN) are not determined by chemical analysis. Neither is digestible protein. TDN and digestible protein may be calculated from the results of a proximate analysis if digestion coefficients are known. They cannot be calculated from the analysis of a mixed feed.

APPENDIX - H

Distribution of Samples Tested in Washington (June 1, 1961 to May 31, 1962)

Forage	Number of Samples	Percent of Total Samples	Range in Crude Protein[a]	Range in Estimated TDN[a]
Hays:	178	70.0		
a. grass	15	8.5	2.8-14.9	40.9-59.0
b. legume	96	54.0	10.6-24.0	36.4-62.6
c. grass-legume mix	67	37.5	5.7-16.7	44.6-65.4
Silages:	75	30.0		
a. grass	12	16.0	6.9-11.4	33.4-54.0
b. legume	10	13.0	10.2-25.2	51.5-70.2
c. grass-legume mix	32	43.0	8.2-18.9	33.8-61.5
d. corn	21	28.0	5.3-11.3	51.3-71.2

[a]based on dry matter

APPENDIX - I

Crude protein content of various types of first-cutting hay[1/]

Type of hay	Crude protein content (dry matter basis)	
	Average	Range
	(%)	
Legume	16.4	9.7-20.5
Mixed, mainly legume	13.6	6.4-22.6
Mixed, mainly grass	10.9	6.3-19.5
Grass	9.6	4.7-17.9

1/ Study conducted at Pennsylvania State University

APPENDIX - J

TDN[a] content of various forages[1/]

Forage	TDN content (dry matter basis) Average	Range
	(%)	
Silages		
Hay-crop	55.3	40.5-73.5
Corn	63.9	43.4-74.3
Other annuals	55.1	39.3-69.6
Legume, mixed mainly legume hays		
First-cutting	57.7	44.1-70.2
Aftermath-cutting	61.5	47.4-76.8
Grass, mixed mainly grass hays		
First-cutting	54.3	39.1-70.4
Aftermath-cutting	59.8	51.5-66.6

[a]Calculated values.

1/ Study conducted at Pennsylvania State University

APPENDIX - K

Influence of date of cutting on TDN[a] content of hay-crop forages[1/]

Interval	TDN content (dry matter basis)			
	Hay	Silage	Combined forages	Research Plots
	(%)			
May 1-20	61.0	57.6	59.5	....
May 15	....	....	....	68.7
May 21-31	60.3	56.2	56.9	....
May 29	....	....	....	60.3
June 1-10	57.5	54.7	55.9	....
June 11-15	56.0	54.6	55.4	....
June 12	....	....	....	55.5
June 16-20	56.2	....	56.2	....
June 21-30	55.0	55.0	55.0	....

[a]Calculated values.

1/ Study conducted at Pennsylvania State University

APPENDIX - L

Cost of Establishing and Operating A Feed Analytical Laboratory[1/]

A. Initial Cost:

	Item	Estimated Cost
1.	Room suitable for a laboratory. It must be large enough to accommodate the necessary machines and equipment and be provided with forced ventilation to remove fumes.	$ 40,000.00
2.	A balance (scales) with weights for weighing large samples.	250.00
3.	An analytical balance (scales) with weights for weighing precise portions for analysis.	500.00
4.	A mill with accessories for grinding samples finely enough to permit uniform mixing.	950.00
5.	An electrically-heated oven with a temperature regulator for determining moisture.	300.00
6.	An electrically-heated furnace with a temperature regulator for determining ash.	500.00
7.	A 12-unit apparatus for determining crude fat.	1,000.00

1/ Developed by E. J. Benne, Department of Biochemistry, Michigan State University

8.	A 12-unit, combination digestion and distillation, apparatus and accessory equipment for determining crude protein	2,500.00
9.	Meter to determine pH values.	400.00
10.	An initial supply of necessary chemicals and reagents.	500.00
11.	An initial supply of necessary glassware.	500.00
12.	An initial supply of paper, pencils, record books, etc.	150.00
13.	A calculating machine for figuring results.	450.00
14.	Desk, file cabinet, chairs, etc.	200.00
15.	Graduate chemist with sufficient experience to insure analytical work of high quality.	10,000.00
	Total	$ 58,200.00

B. Operating Cost:

	Item	Estimated Cost
1.	Rent, utilities, supplies (includes general help for dishwashing, typing, etc.). This is assuming there is adequate volume of work.	$ 10,000.00
2.	Graduate chemist.	10,000.00
	Total	$ 20,000.00

APPENDIX - M

FEED ANALYSIS SURVEY

Farmer's Name_____ Date_____

Sample No._____ Type of Sample_____

Sample Analysis

Percent Moisture_____ Percent Fat_____

Percent Protein_____ Percent Ash_____

Percent Fiber_____ Percent N.F.E._____

Cattle Information:

Number_____

Age_____

Sex_____

Weight_____

Days on Feed_____

Daily Ration Information:

Ingredients	lbs/hd/day
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Are Calcium and phosphorus fed_____free choice____mixed in ration _____?

Are trace minerals fed_____in salt_____mixed in ration_____?

Corn Silage:

Estimated yield per acre_____, fineness of chop_____, frost free_____, moisture_____.

Corn:

High moisture_____%_____; Dry_____%_____.

Shelled cracked_____Shelled rolled_____Ground ear_____.

Hay:

Kind_____

Quality_____

Leafy_____

Stemmy_____

Green Color_____.