DEVELOPMENT AND MARKETING ALTERNATIVES FOR CATTLEFEED PRODUCED FROM WATER HYACINTHS

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Final report of a study conducted by AMASEK, Inc. in cooperation with J. Don Jones, D.V.M. and Brian McAdams, D.V.M., for the Florida Department of Agriculture and Consumer Services, Project No. 1-DA1.

The use of water hyacinths for nutrient removal and resource recovery in wastewater treatment systems has been demonstrated by AMASEK, Inc., in several treatment systems throughout Florida. These systems have consistently exceeded minimum Advanced Wastewater Treatment (AWT) requirements with Nitrogen removal to levels of 1.5 mg/l or less and Phosphorus removal to levels of 0.2 mg/1 or less. Water hyacinths grown in wastewater have demonstrated the ability to produce 250-500 dry pounds of vegetative material per day per acre (Stewart et al., 1984, Wolverton and McDonald, 1978), of which about 13-18% is protein and 32-38% is fiber on the average. The annual yield potential of this crop is 10-20 tons of protein per acre. Considering the extent of this productivity and the market potential determined by Dr. Lee Meyer, an agricultural economist at the University of Kentucky (see Appendix A), AMASEK has directed their efforts towards developing a low cost, high protein and fiber feed supplement. Based on discussions with dairy and beef farmers in Florida, Dr. Meyer's conclusions that material of this quality could find a reliable and sizable market in Florida were verified.

Based upon early indications that water hyacinths could be managed to produce a viable feed product, AMASEK designed, purchased and installed a prototype feed production unit at the City of Kissimmee's Martin Street Wastewater Treatment Facility. This unit was used in conjunction with a state sponsored, four acre water hyacinth based, advanced wastewater treatment demonstration project, designed with the intent of achieving low, nutrient levels being discharged into Reddy Creek. It was proposed that this system serve as a source of plants for the development of a feed ingredient to be utilized in a series of feed trials with both beef and dairy cattle.

Subsequent to discussions with the Florida Department of Agriculture, dairy and beef farmers, and a request for proposal from the Department, a feed trial program was developed and submitted to the Department of Agriculture and Consumer Services (DACS). The proposed program consisted of harvesting, and processing water hyacinths into a chopped dried feed ingredient and producing a hyacinth feed blend for comparative testing with other feed product blends utilizing beef and dairy cattle.

In June 1987, AMASEK and DACS entered into an agreement to conduct a feed trial program using beef and dairy cattle. During the feed trial, monitoring of critical parameters such as weight gain, feed palatability, general animal health and milk quality would be conducted. The program work tasks were designated as: feed production, qualitative and laboratory analysis, development of a feed blend, the feed trial program, and a final report to include marketability and overall economic assessment. The findings of the feed study program are included in this final report as Part I: Beef Cattle Feed Trial, and Part II: Dairy Feed Trial.

PART 1: BEEF CATTLE FEED TRIAL

INTRODUCTION

A large number of beef cattle existing in Florida and surrounding areas represents a potential market for a low cost, suitable feed ingredient for growing and finishing cattle. Several analyses of the water hyacinth (WH) feed product indicates that it is relatively high in protein, fiber and minerals. The WH feed is similar to alfalfa hay in many of its characteristics however, there is a considerable range in percentage content of particular nutrients, depending on the environment in which the hyacinths were grown. Higher protein levels in the plants (> 20%) seem to correlate with wastewater treatment systems receiving higher nutrient loadings. Management of these systems through regular harvesting also appears to maintain higher protein levels in the plants. Table I-1 presents a comparison of WH with various feed ingredients.

With the assistance of an Orlando, Florida veterinarian, Don Jones, D.V.M., a beef cattle facility was selected to participate in the beef cattle feed trial program at L.D. Plante, Inc., a retired animal rendering facility located at 2950 Railroad Avenue, Oviedo, Florida (the facility is located on SR 419 several miles north of Oviedo). The owner, Don Plante, agreed to offer the use of a dry feed storage area, feed mixing equipment, weighing scales (for feed and cattle) and two isolated one-acre corals for conducting the program. Don Jones, D.V.M., agreed to conduct general animal health checks on the premises.

TABLE I-1
COMPETING FEEDS AND WATER HYACINTH NUTRIENT VALUES (DRY MATTER BASIS)

	Dry Matter (%)	Protein (%)	TDN (%)	Fiber (%)
Alfalfa Hay	88	16	57	31
Coastal Bermuda Hay	91	9	53	31
Corn, Grain	89	10	90	2
Corn, Silage	40	8	70	25
Soybean Meal	89	51	85	3
Mollasses, Wet	75	4	72	0
Cottonseed Meal	93	42	84	13
Sugarcane Baggage	90	2	48	49
Water Hyacinth	90	20	55	18

Source: National Academy of Sciences, Nutrient Requirements of Beef Cattle, (Fifth Revised Edition), 1976, Washington, D.C.

OBJECTIVES

The objectives of the feed trial programs, consistent with the agreement with DACS were rather general and became more clearly defined as the studies were set-up. After harvesting and processing a sufficient tonnage of water hyacinths for animal feed, an acceptable feed blend was to be developed. The beef cattle feed trial itself was to involve, at a minimum, the monitoring of critical parameters such as weight gain, feed palatability and general animal health. It is obvious that palatability of the WH ingredient is a primary

parameter to be measured. Once determined, practical proportions in a standard ration would be arrived at with subsequent laboratory analysis allowing comparison of the WH feed blend with other standard rations. This comparison would then allow for evaluation of nutritive value, through analytical results of the feed itself and response of the Test animals. Monetary values of the water hyacinths would then be determined by calculating values, of the ingredients for which the water hyacinths were substituted for the standard rations. The overall assessment of feed performance with initial economic considerations is presented in this final report.

DEVELOPMENT OF WATER HYACINTH FEED PRODUCT

Water hyacinths used as a feed source for the Beef Cattle Feed Trial (Part I) and the Dairy Feed Trial (Part II) were processed at the Martin Street Wastewater Treatment Plant (WWTP) in the city of Kissimmee, FL. The WWTP has a design capacity of 3.0 MGD which is directed through two (2) hyacinth treatment ponds, each pond being two acres in size and hydraulically interconnected. The hyacinths are harvested on a regular basis as part of the treatment system management program. Harvesting is conducted using AMASEK's Model 101 harvester/processor, described in Appendix B, which has a processing capacity of 10-12 wet tons of hyacinths per hour. The rate can be regulated to accommodate the chosen method of final processing. The harvesting process results in a finely chopped slurry material consisting of 4-5% solids with the largest particle size being no more than 0.25 square inches.

For purposes of feed production, the chopped hyacinth slurry was pumped to a horizontal screw press as 4-5% solids. After partial water removal the material was immediately delivered to a low temperature batch flow dryer as 15% solids. The hyacinths remained in the dryer for approximately 24 hours where the maximum temperature reached 105 degrees F., but was normally maintained at 10-15 degrees F., above ambient temperature (85 - 95). At the end of the drying time the moisture content was reduced to create approximately 85% to 90% solids.

The dried hyacinth material (feed product) was transferred from the dryer, as produced, and placed in 2-ply paper feed bags and tied closed. Each bag was filled with 17-20 pounds of material, marked to indicate, date of production, placed on pallets and stored within the storage building on-site. Approximately 1000 pounds per month of dried hyacinth material were produced and stored during the months of May, June, July, August and September 1967.

HYACINTH QUALITY

Water hyacinths produced and processed at the Kissimmee WWTP were subjected to qualitative analyses by Triple "S" Laboratories, Inc. in Loveland, Colorado and A & L Great Lakes Agricultural Laboratories, Inc. in Port Wayne, Indiana. (Original analytical sheets are included in Appendix C). These laboratories were recommended by Don Jones, D.V.M. in Orlando. As a comparative standard, analyses of hyacinth feed product (by A & L Laboratories) were available from April, 1986 when several batches were produced to assess the effectiveness of the process. Table I-2 presents the results of these batch analyses, which represent the plant quality which could be expected following processing of the Kissimmee plants. While these analyses present total protein values somewhat lower than what is typically found in unprocessed water hyacinths from all other AMASEK facilities combined (Table I-3 presents ranges and averages for unprocessed

hyacinths from AMASEK facilities) the August 1987 analyses for the feed trial product resulted in even lower total protein levels. As previously discussed, water hyacinth constituents may vary considerably depending on the characteristics of their environment. In situations where nutrient loadings are relatively high (Total Nitrogen = 20-30 ppm, Total Phosphorus = 3-5 ppm) as in many secondary wastewater treatment facilities, Total Protein in the plants would be expected to average approximately 16% (Table I-3). Processed hyacinths from Kissimmee, which were expected to contain 13-14 percent Total Protein (Table 1-2) actually contained 12 percent protein. This "lower than expected" protein level ultimately resulted in a feed ration more representative of the Nutrena® standard beef cattle feed (used in the cattle feed blend) with a guaranteed analysis of 12 percent minimum crude protein. Appendix C contains the complete analysis and ingredients of the Nutrena® beef cattle feed.

TABLE I-2
APRIL 1986 ASSESSMENT OF HYACINTH FEED PROCESS AT KISSIMMEE, FLORIDA, CATTLE FEED INGREDIENT DUALITY

	Batch #1	Batch #2	Batch #3	Whole Plants
Moisture	7.4	19	7.62	95
Fat	.3	.1	.3	2.95
Crude Protein	13.78	13.47	13.28	15.7
Digestible Protein	9.37	9.16	9.03	
Fiber	32.96	33.79	30.03	33.9
TDN	59.63	58.92	62.18	
Energy Therms/100#	46.41	45.29	50.37	
NE Lactation Mca/#	.56	.55	.61	
Calcium	2.1	2.1	1.9	1.93
Phosphorus	.488	.426	.365	.488
Potassium	2.66	2.67	2.07	3.55
Magnesium	.346	.359	.27	.345
Sodium	.39	.43	.42	.555
Sulfur	.328	.276	.254	
Iron PPM	1770	1710	1940	1115
Manganese PPM	93	97	79	81.7
Copper PPM	13	16	10	
Selenium PPM			26.7	202
Zinc PPM	30	40	45	117
Water Soil Nitrogen	.0021	.0025	.1271	
Ammonia	.0086	.0234	.0675	
Acid Detergent	39.2	40.3	35.3	
Unavailable Crude Protein	6.13	6.28	3.91	

TABLE I-3
ANALYSIS OF UNPROCESSED WATER HYACINTHS FROM
AMASEK WASTEWATER TREATMENT FACILITIES

Parameter	# Values	Range	Average	S.D.
Protein	44	5.84-24.68	15.7	4.29
Fiber	44	18.82-50.6	35.42	6.30
Nitrogen	34	1.0-4.9	3.10	1.0
Phosphorus	34	0.18-1.12	0.68	0.28
N/P Ratio	34	2.14-15.26	5.44	3.02
Potassium	34	2.9-5.75	4.41	0.73
Iron	34	166-1980	618	369
Calcium	34	0.9-2.3	1.53	0.3
Boron	34	13-135	33.0	20.0
Copper	34	6-225	41.0	47.0
Sulfur	34	0.27-1.22	0.66	0.23
Zinc	34	16-184	41.0	47.0
Aluminum	34	60-3520	490	596
Nickel	7	<.5-13.0	4.57	3.74
Lead	7	<.5-5.0	1.86	1.99
Magnesium	34	0.23-0.63	0.36	0.07
Manganese	34	60-1220	226.0	207
Molybdenum	12	<.5-13.5	5.43	4.06
Cadmium	7	<.05-5	0.21	0.20
Cobalt	7	<.5-5	1.50	1.49

Table I-4 presents analytical results for three conditions of the hyacinth feed product: 1) a representative sample of chopped hyacinths was oven dried and analyzed as “Hyacinth Before Press”, 2) another representative sample was oven dried and analyzed as “Hyacinth After Press”, and 3) “Hyacinth Composite” represents a composite sample of the dried product taken from six bags which were produced over a three month period. For consistency all results are presented on a dry weight basis. Analytical sheets contained in Appendix C also report the “AS IS” analysis, which reflects the moisture content.

The lower than anticipated protein levels in the processed water hyacinths can be explained by the nature of operations at the Kissimmee WWTP. While the total discharge from the Martin Street facility remained within permitted discharge parameters, the influent quality and quantity was highly variable. Due to on-site construction activities flow was restricted at times and varied between 0 and 3.5 MGD. Restricted flow resulted in nutrient deprivation, especially for the plants furthermost from the influent. Nutrient uptake in the system was cyclic resulting in stressed plants, which contained a considerable amount of nonviable tissue (not actively growing, nor containing sufficient chlorophyll levels). Also the logistics of the system only allowed access to the older, more fibrous plants, with as much as 30% nonviable tissue, and not the pond area containing plants in optimum growth phases which were of higher quality.

TABLE I-4
QUALITATIVE ANALYSIS OF HYACINTH MATERIAL, WASTE WATER TREATMENT PLANT, KISSIMMEE, FLORIDA. AUGUST 1987

Parameter (% dry weight unless noted)	Before Press (Oven Dried)	After Press (Oven Dried)	Composite (Dried Product)
Total Protein	11.88	11.83	12.26
Digestible Protein	8.18	8.10	8.67
Crude Fat	1.13	1.14	1.09
Crude Fiber	32.32	33.07	34.14
Ash	6.91	5.75	9.13
Nitrogen Free Extract	47.76	48.21	42.88
Total Digestible Nutrients	58.37	59.26	55.34
Nitrate As KNO3	0.00	0.00	0.00
Beta Carotene ug/lb	1.10	1.00	8.60
Phosphorus	0.31	0.25	0.37
Magnesium	0.24	0.19	0.29
Potassium	1.18	0.90	1.62
Sodium	0.21	0.14	0.24
Sulfur	0.26	0.20	0.32
Manganese PPM	55.50	45.60	70.00
Copper	9.40	4.40	9.10
Cobalt	0.83	0.79	1.31
Zinc PPM	115.40	66.30	101.40
Iron PPM	298.30	215.80	1759.20
Molybdenum PPM	3.30	2.60	4.00

The water hyacinths used for producing an animal feed product for the feed trials while less than optimum, did nonetheless, produce an acceptable feed product. While the study represents the evaluation of an acceptable feed ingredient, a higher quality ingredient is obtainable through the use of optimum plants managed under more consistent conditions.

The water hyacinth feed composite was also analyzed for mineral and heavy metals by Triple “S” Lab, Inc., and A & L Laboratories (Lab data sheets contained in Appendix C) Table I-5 presents the Dry Weight based analysis and the maximum tolerance level for cattle of each parameter. The high iron content (1759.2 ppm) was due to the iron residue (rust) in the batch flow drier. The concentration diminished as the drier was utilized and was no longer of concern. The aluminum content of 500 ppm is the result of the aluminum treatment for settling purposes, typical at the Kissimmee WWTP. Considering a 10-15% hyacinth feed ingredient, the aluminum concentration, and concentrations of other elements, such as calcium, which slightly exceeds the tolerance level in the 100% hyacinth material, will not be of major concern. Many treatment facilities do not utilize the alum process, or use the process to a limited extent. Aluminum concentrations would he expected to be much lower in future feed production.

TABLE I-5
HYACINTH FEED MINERAL AND METAL ANALYSIS INCLUDING
MAXIMUM TOLERANCE LEVELS FOR CATTLE*

Parameter	100% Hyacinth Material Feed Analyses (Dry Wt. PPM unless noted)	Blended Feed Tolerance Level for Cattle (PPM unless noted)
Chloride	3700	4% NaCl
Cadmium	0.2	0.5
Nickel	3.3	50
Lead	4.4	30
Aluminum	500	1000
Mercury	0.43	2
Selenium	0.12	2
Calcium	2.262%	2%
Phosphorus	0.369%	1%
Magnesium	0.291%	0.5%
Potassium	1.619%	3%
Sodium	0.235%	4% NaCL
Sulfur	0.322%	0.4%
Manganese PPM	70.0	1000
Copper PPM	9.1	100
Cobalt PPM	1.31	10
Zinc PPM	101.4	500
Iron PPM	1750.2	1000
Molybdenum PPM	4.0	10

*****National Academy of Sciences, Nutrient Requirements of Beef Cattle, (Fifth Revised Edition), 1976, Washington, D.C.

DEVELOPMENT OF FEED BLEND AND FEED TRIAL

On September 16, 1987, a group of twelve (12) Angus and Brangus calves varying in age from 6-9 months were selected (based on an approximate weight of 450 to 500 pounds) at the L.D. Plante facility near Oviedo, Florida. The cattle were tagged and divided into two six-head groups: a Test group and a Control group under the supervision of Dr. D. Jones. The calves were identified as follows:

TEST GROUP			CONTROL GROUP		
#16	Angus	- heifer	#20	Angus	- heifer
#18	Brangus	- heifer	#21	Angus	- heifer
#373	Brangus	- heifer	#48	Brangus	- heifer
#163	Brangus	- heifer	#19	Brangus	- heifer
#17	Angus	- bull	#234	Brangus	- heifer
#284	Angus	- steer	#339	Brangus	- steer

Each calf was found to he in good health as determined by a general health check conducted by Don Jones, D.V.M., his observations are provided as Appendix D. Each group was separated and confined on 2 acres of pasture having adequate shade and water.

Since prior feeding for these cattle had been restricted to forage (pasture), both groups were fed a standard cattle feed (Nutrena® Beef Kwik, guaranteed Analysis contained in Appendix C) for 5 days so that the calves could grow accustomed to the new feed source before actually starting the feed trial. The Test group's standard ration included 10 percent hyacinth feed.

Both groups were initially fed 18 lbs. of total feed daily. This method of feed introduction was conducted to acclimate the recently weaned calves and to make initial observations regarding palatability of the hyacinth feed ingredient, and develop the maximum blend (percent hyacinth feed) that would be practical in the feed trial.

The standard Nutrena® feed and the hyacinth food were weighed and mixed by hand to create the appropriate percent by weight blend. Hand mixing did not result in complete homogenization of the two feeds. During most feedings the heavier standard feed would settle out in the trough leaving the hyacinth feed as more of a top dressing. The cattle, however, ate the separated hyacinth feed and standard feed without discrimination.

After the initial 5 days of feeding, total feed weight was increased to 24 lbs. for both groups with the Test group receiving 20 percent hyacinth feed (4.8 lbs) per day. Observations of the Test group revealed that the animals feeding on 20% hyacinth feed, would leave a trace amount (1 lb or less) of the hyacinth material in the trough and later return and finish the feed. The 20% hyacinth blend was determined to be a maximum blend based on these observations and the professional opinions of AMASEK personnel and Don Jones, D.V.M. The 20% hyacinth blend was maintained throughout the course of the study. Increases in total daily feed weight presented to the two groups was also based on consumption. When the cattle were observed emptying the entire trough of feed at one feeding, the feed rate was increased, in equal amounts for each group, usually by 10 lbs. Table I-6 tracks the feeding rates throughout the course of the feed trial (field data sheets are presented in Appendix E). On October 1, 1987 each group of calves was weighed separately on a large commercial scale at the L. D. Plante site. For comparative purposes this officially began the feed trial study.

RESULTS AND CONCLUSIONS OF FEED TRIAL

A foremost observation during initial feedings in the study was palatability of the water hyacinth feed ingredient to the cattle. As previously discussed, the WH feed separated from the heavier standard feed. All six animals in the Test group were observed eating the WH feed virtually in a "straight form". These observations indicate that the water hyacinth ingredient would be well received in a homogenized blend.

The period between September 16 and October 1, 1987 was an acclimation and stabilization period for the recently weaned calves. According to Dr. Jones, calves may lose 10-15% of their body weight in the following 30-45 days after weaning, especially when a new feed is introduced simultaneously. The animals ate well consuming 100% of the feed offered to them, and never exhibited any signs of significant weight loss.

TABLE I-6
GROUP FEEDING RATES FOR BEEF CATTLE FEED TRIAL

Date of Period	TEST GROUP (6) Hyacinth Blend	lbs/day	CONTROL GROUP (6) Std. Blend** lbs/day
09/17 - 09/21/87	10%	18	18
09/22 - 09/28/87	20%	24	24
09/29 - 09/30/87	20%	35	35
10/01 - 10/09/87	20%	45	45
10/10 - 10/15/87	20%	55	55
10/16 - 10/18/87	20%	60	60
11/19 - 12/17/87	20%	100	100

* Percent by weight of Hyacinth feed product blended with the standard feed.
**Nutrena® Beef Quick

On October 1, 1987 each group of six was placed in a cattle trailer and weighed on a large commercial scale on-site (weight slips are contained in Appendix E). The total weight of the Test Group was 3,240 lbs., an average of 540 lbs. per calf. The total weight of the Control group was 3,260 lbs., an average of 543 lbs. per calf. On this date both groups were given 45 lbs. of feed daily, increasing to 60 lbs. daily on October 16th (Table I-6). All animals appeared to be in good health. General observations of the animal's (Test and Control group) fecal material indicated that the calves had adapted well to both feed blends after weaning and coming off regressing pasture.

Feedings continued at the rate of 60 lbs. per day for both groups through November 16, 1987 with the Test group receiving a blend of 12 lbs. hyacinth feed and 48 lbs. standard feed. On November 16, both groups were reweighed using the method discussed above. This weighing indicated a 340 lb weight loss for the Control group and a 260 lb loss for the Test group. These results were suspect as the cattle did not physically appear to have lost a significant amount of weight, with the exception of #163 in the Test group. This calf, a Brangus heifer, was observed to be in a deteriorating condition resulting in noticeable weight loss. The exact cause of this calf's poor condition was not determined at the time.

At this time it was recommended that the beef cattle feed trial be extended for an additional 30 days. This recommendation was based on the suspected weight loss, which was thought to be due to the calves being recently weaned, and the need for an extended period to identify any general trends, which was an objective of the study.

The extended feed trial, from November 17 through December 18, 1987 continued with the use of a standard feed for the Control group and a 20% hyacinth/standard feed blend for the Test group. However, unlike before, each group was fed the maximum amount of feed that could be eaten in a 24 hour period. It was determined that 100 lbs. Total feed (Test group was fed 20 lbs hyacinth & 80 lbs. standard feed) would be consumed in a day with only a small amount (1-3 lbs.) left in the trough at the end of the 24 hour period. Both groups were fed at this rate until December 18, 1987.

On December 18, 1987 the Control group and Test group were reweighed, with the weighing supervised and determined to be correct. The Control group weighed 3,600 lbs and the Test group weighed 3,440 lbs. If this weighing is compared to the November

weights (see Table below), a significant weight gain is indicated for both groups. It is unlikely that the Control group gained 680 lbs. and the Test group 460 lbs. in four weeks considering the condition of the animals in this study. Since the total weight was questionable in the November weighing, this weighing was omitted for comparative purposes. The beginning and end weight are used to identify general trends addressed in this study.

CATTLE WEIGHINGS
NET WEIGHT IN POUNDS (LBS.)

Date	Control Group (6)	Test Group (6)
October 1, 1987	3,260 lbs.	3,240 lbs.
November 16,1987	2,920 lbs.	2,980 lbs.
December 18, 1987	3,600 lbs.	3,440 lbs.

A comparison of the beginning and end weights (October vs. December) indicates a reasonable weight gain for the study period, considering that there may have been some initial weight loss, and the general conditions and status of these animals, the Control group increased 340 lhs., an average of 57 lbs. per calf, and the Test group increased 200 lbs., an average of 33 lhs. per calf. Both groups recaptured the weight lost early in the study and increased their weight above starting levels. Calf # 163, in the Test group, recovered from her poor condition during the last 30 days of the trial and showed noticeable improvement and weight gain. The total weight gain differential between the two groups may partially be explained by the inconsistent conditions of this calf during the study. This cannot be quantified since the animals were not individually weighed. The fact that this animal did recover while on the hyacinth feed is positive and indicates some nutritional attributes of the feed with no problems of toxicity.

SUMMARY

Conclusions of the Beef Cattle Feed Trial, concurrent with those of Dr. J. D. Jones, D.V.M., (Appendix D) are:

- The Hyacinth Feed is palatable to cattle. Considering the fact that the Test calves virtually ate the feed in a straight form along with standard feed indicates that adult cattle would probably eat blended feed with hyacinth levels greater than 20 percent.
- There were no apparent detrimental effects of the hyacinth feed in relation to toxicity. The fact that a sickly calf was able to recover (recover lost weight) while on the feed indicates some nutritional quality of the hyacinth feed. This is also indicated by a net weight gain for the Test group.
- Realizing that higher quality water hyacinths containing more protein are available from different sources supports a closer comparison of hyacinth feed with alfalfa and other forages as a feed supplement.
- The positive results of this feed trial warrant a longer term, more controlled feed trial to confirm observed trends and quantify the value of hyacinths as a feed supplement.

PART II: DAIRY FEED TRIAL

INTRODUCTION

The current dairy cow inventory in Florida (> 200,000) represents a potential large demand for a good quality feed supplement. The results of the Beef Cattle Feed Trial (Part I), conducted October through December 1987, indicated that the water hyacinth (WH) feed supplement was palatable, and was consumed without any detrimental effects to the Test animals. The favorable results of this study led to the development of a more controlled feed trial tailored for dairy cows.

Dairy cows were selected for a feed trial, not only because of the large potential feed market, but because they are highly productive animals requiring considerably greater amounts of total digestible nutrients (TDN) than beef cattle, thus serving as a better indicator of feed value. Depending on a dairy cow's physiological state, digestible nutrients and energy requirements may be thirty-five times higher than beef cattle in a maintenance phase (Cole, 1962). Dairy cows are good indicators to use in short term studies due to their quick response to feed values which can be measured by their daily milk production.

Dairy selection was based upon: the dairy's capabilities of separating the Test group and Control group, measurement of daily milk production, access to a licensed veterinarian familiar with the herd for conducting animal health exams, and the dairy's willingness to participate in the feed trial. A 200 head dairy was selected based on the above criteria. The dairy is owned by Mr. and Mrs. Mike Wiederkehr located at Spring-Top Dairy, P. 0. Box 191, White Springs, Florida, 32906. Spring-Top's associated veterinarian, which agreed to participate under a separate agreement with AMASEK is Brian L. McAdams, D.V.M. of Suwannee Oaks Animal Clinic, Inc., O'Brien, Florida.

OBJECTIVES

The objectives of the Dairy Feed Trial were more defined than those of the beef cattle feed trial. Due to the productive nature of the dairy cow, additional parameters could be monitored to evaluate response to the water Hyacinth (WH) feed ingredient and general animal performance. Palatability of the WH ingredient was established in the beef cattle study and became a secondary objective in the dairy cow study.

An initial objective, not addressed with the beef cattle, was a nutrient balanced feed for both the Control group and Test group. This was attained by replacing a component (cottonseed hulls) of the standard feed mix with WH and subsequent adjustment of all other components so that the test feed and Control feed were equal on a nutritive basis. This would allow for the evaluation of WH as a true feed ingredient.

Assessment of the WH feed value was to be determined in the study by monitoring: general animal health, daily milk production, milk quality, weight gain/loss, and feed consumption as an indicator of nutrient utilization and palatability. The overall assessment of feed performance with economic considerations is presented in this final report.

DEVELOPMENT OF WATER HYACINTH FEED BLEND

Water hyacinths used for the dairy feed ingredient were harvested from the WWTP in Kissimmee, Florida and processed per the methods discussed in Part I of this report. Harvesting and processing took place during September and October 1987. Samples

of the dried WH product were taken from several 20 lbs. bags and composited to represent the WH feed used in the dairy study. Samples were analyzed by Triple "S" Lab in Colorado and A & L Laboratories in Indiana. Original laboratory data sheets are included in Appendix E. Below, is a dry weight comparison of the plant quality used in the beef cattle feed trial.

Parameter	Beef Cattle Feed	Dairy Feed
Total Protein (%)	12.76	10.75
Crude Fat (%)	1.09	0.63
Crude Fiber (%)	34.14	34.37
TDN (%)	55.34	49.42

As previously discussed in Part I, the quality of the plants at the Kissimmee, Florida WWTP were less than optimum due to existing conditions at the facility. These conditions persisted which resulted in lower than anticipated Total Protein levels in the dried Hyacinth feed.

Spring-Top Dairy relies on the Tampa Independent Dairy Farmers' Association, Inc. (TIDFA) for providing a standard feed formula (see Table II-1). For developing a hyacinth feed blend equivalent to the standard blend, Al Sanchez, nutritionist with TIDFA, was asked to assist with the formulation. Taking into consideration the palatability and quantity of WH feed consumed in the beef cattle feed trial, and the laboratory analysis of the WH feed (see Appendix E), AMASEK, the nutritionist, and the dairy determined that a feed blend containing a 10% hyacinth mixture was most practical. To accommodate a 10% hyacinth ingredient, cottonseed hulls were removed from the standard feed formula and adjustments were made for protein, TDN, and crude fiber. Table II-1 compares the ingredients contained in the standard feed blend to the adjusted ingredients list for the 10% hyacinth feed blend. The ingredient of the standard feed were adjusted to result in an equivalent hyacinth containing feed in respect to nutrients and minerals. Table II-2 and Figure II-1 illustrates how closely the two feeds approximate one another (TIDFA Nutrient Balance sheets are included in Appendix E).

ANIMAL SELECTION FOR DAIRY FEED TRIAL

The selection of healthy, top producing Holstein cows was conducted by Dr. Brian McAdams, D.V.M. on December 9, 1987. Criteria used to select the cows were:

- Date of Parturition (calf date)
- Term of lactation
- Milk production
- Pregnancy status
- Size and weight
- General animal health

The objective was to select consistent animals in terms of production, not stressed by excessively high production or rapid growth of fetus. By grouping cows based on their last calf date it is assumed that they will fall generally in the same stage of lactation. Following parturition the udder is stimulated, resulting in increased milk production, which

peaks around the sixth week. After this time there is a gradual decline in milk production until the cow is permitted to "dry up" for her ensuing parturition and next lactation period. Figure II-2 illustrates the classical lactation curve.

TABLE II-1. TAMPA IDFA – DAIRY FEED FORMULATIONS

Ingredient *	Standard Feed	10% Hyacinth Feed
Ground Corn Meal	28.70	29.56
SBM – 48%	18.40	17.84
Soybean Hulls	12.00	7.50
Wheat Midds	12.50	12.50
Cottonseed Hulls	5.80	0.00
Whole Cottonseed	15.00	15.00
Sodium Bicarbonate	1.00	1.00
Calcium Carbonate	1.70	1.70
Dikal – 21%	0.60	0.60
Salt	0.50	0.50
Vit/Min Premix	1.30	1.30
Cane Molasses	2.50	2.50
Dried Hyacinth	0.00	10.00

* All ingredients expressed as percent of Total Feed

FIGURE II-1
TAMPA IDFA
FEED BLEND NUTRIENT BALANCER

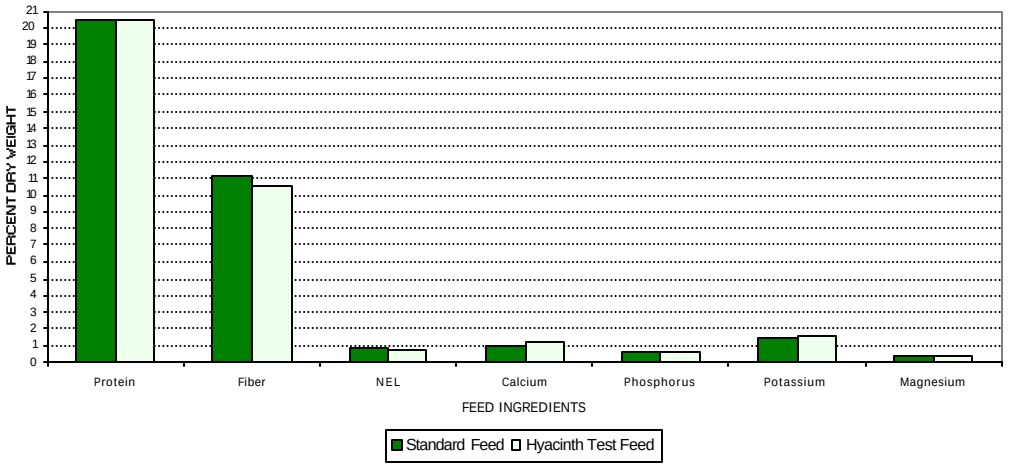
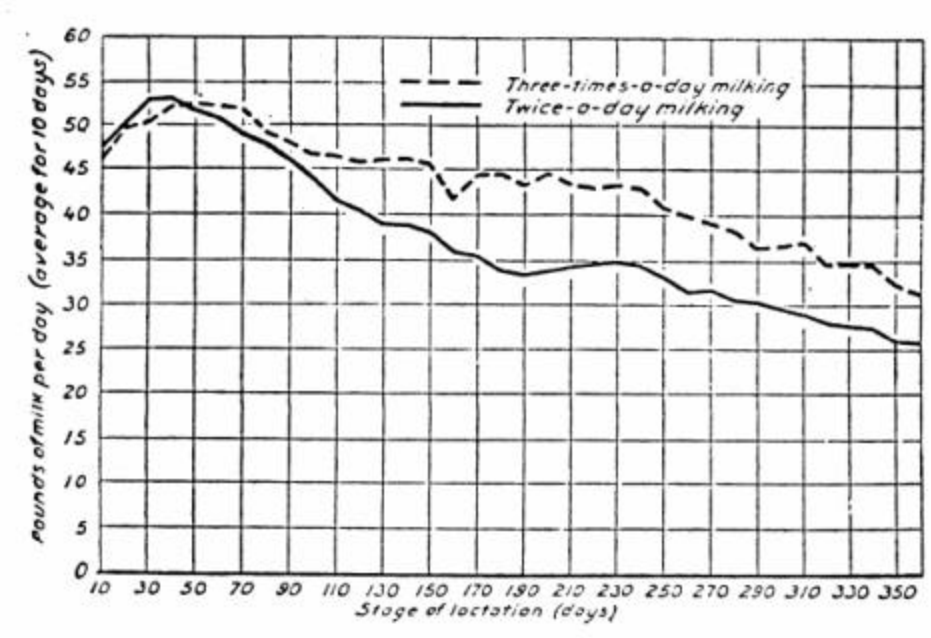


TABLE II-2. COMPARISON OF QUALITATIVE ANALYSES OF THE STANDARD FEED BLEND AND 10% HYACINTH BLEND

Parameter*	Standard Feed	10% Hyacinth Feed
Dry Matter	90.15	90.01
Moisture	9.85	9.90
Crude Protein	20.43	20.46
Mcal/LB	0.82	0.76
TDN	79.00	78.52
Crude Fiber	11.10	10.54
A.D. Fiber	18.95	17.48
Sulfur	0.35	0.35
Phosphorus	0.62	0.64
Potassium	1.48	1.54
Magnesium	0.34	0.35
Calcium	0.96	1.14
Sodium	0.61	0.60

* All concentrations expressed as percent.

FIGURE II-2. *LACTATION CURVES ILLUSTRATING THE EFFECT OF FREQUENCY OF MILKING ON LACTATION PERSISTENCY. (FROM WOODWARD). *TAKEN FROM COLE, 1962.



Approximately eighteen cows were identified based on the above criteria. From these eighteen, six (6) were randomly selected and placed in the Test Group and six (6) were designated as Control Group. Following examination of the cows (uterus palpation) two were determined to be pregnant. These two were separated, placing one in the Test Group and the other one in the Control Group. [Each cow was tagged for identification purposes.] Table II-3 characterizes the animals selected for the two groups.

General health examinations of the animals were conducted by Dr. McAdams. The results of these exams are presented in Dr. McAdams' report included in Appendix F. Health examinations included:

A. Blood Test (25 smack test) to include a complete blood count – start and end of trial.
B. Reproductive Exam (uterus tone) – start and end of trial.
C. Fecal Exam – start and end of trial.
D. Weight and Temperature – start, midway, and end of trial.
E. General Observation – start, midway, and end of trial.

TABLE II-3. CHARACTERISTICS OF COWS SELECTED FOR DAIRY FEED TRIAL

	Test Group (Hyacinth)						Control Group (Standard)					
Cow ID #	73	189	209	242	374	508	29	105	197	278	367	369
Weight (lbs)	1321	1288	1206	1142	1137	1468	1531	1419	1419	1403	1321	11.90
Calf Date (1987)	Aug 10	Aug 10	June 7	Aug 13	Aug 16	Aug 13	Aug 10	Aug 9	June 6	Aug 7	Aug 10	Aug 13
Milk Production lbs/day for Previous 5 days	49	52	43	45	48	62	59	53	46	51	50	48
Uterus Tone	OK	OK	OK	OK	Preg.	OK	OK	OK	OK	Preg.	OK	OK

* All cows examined December 9, 1987

METHODS

Physical mixing of the feed was accomplished on site by a small mechanical mixer. Based on a feeding rate of approximately 40 lbs. of feed per cow per day, mixing was conducted as follows:

The feed mixture per Test animal per day was--

- 36 lbs. standard feed
- 4 lbs. dried hyacinths
- 53 lbs. of silage

Bulk mixing was conducted daily for the Test group, which consisted of:

- 216 lbs. standard feed
- 24 lbs. of hyacinths
- 318 lbs. of silage

The ratio of feed for each Control animal was:

- 40 lbs. standard feed
- 53 lbs. silage (per day)

Physical mixing was conducted until all formulations were mixed to homogeneity.

Operations at Spring-Top Dairy were set-up such that milking and feeding were conducted twice daily. The Test cows were separated from the herd by confining them in a one acre dry lot. Water and shade were provided, and a bale of hay kept in the area for free choice feeding. The Test cows were milked and fed in the barn, separately from the herd. The daily bulk feed was mixed and divided in half for the morning and evening feedings. At feeding time each half was again divided into six equal portions and placed in the six bins in the feed bunk. The six Test animals were allowed to feed for 2 hours. They were then removed from the barn and the amount of feed consumed was noted.

The Control animals remained with the rest of the herd. They were identified by tag number and a red band around the hind leg. Control animals were fed at feed areas in the pasture. The herd was also provided a bale of hay for free choice.

Milking was conducted twice daily, early morning and evening, in a six stanchion herringbone style milking parlor. Each milking station was equipped with scales for weighing daily milk production. The Test group was always brought to the barn first, milked and fed, and turned back out to the dry lot. The herd was then brought in to milk and turned back out to the pasture where they were fed in the herd lot bunker. These activities were maintained on a consistent schedule throughout the course of the feed trial.

RESULTS AND DISCUSSION

On December 9, 1987 the Test group and Control group were identified and separated. Both groups were fed the standard feed ration for five days and monitored to identify any significant changes in production due to the separation, particularly, for the Test group. On December 14, 1987 the feed trial began by feeding the Test group the hyacinth feed blend. The feed trial continued through January 10, 1988 for 28 days.

As previously mentioned general health examinations were conducted by the dairy's veterinarian at the beginning, middle, and end of the feed trial (see Appendix F). The initial examination indicated that the animals selected were in good health with no obvious signs of diseases or parasites. Their body conditions were considered to be normal for lactating cows.

As anticipated palatability of the hyacinth feed blend was demonstrated as the Test group fed readily without hesitation. Feed consumption by the Test group was observed to decrease slightly after nine (9) days into the feed trial. The Test group's average feed consumption during the feed trial decreased by ten percent. This observation cannot be compared to the Control group because feed consumption could not be measured on the individual animals feeding with the herd. Table II-4 presents the average feeding rate (Test group only), total weight gain and average milk production for both groups. (The Dairy's computer data sheets with daily recordings are provided in Appendix E).

TABLE II-4. DAIRY FEED TRIAL (28 DAYS). STANDARD FEED VERSUS TEN PERCENT HYACINTH FEED

	Test Group (Hyacinth)						Control Group (Standard)					
Cow ID #	73	189	209	242	374	508	29	105	197	278	367	369
Average Daily Feed Consumption (%)	93	92	83	88	88	93	ND	ND	ND	ND	ND	ND
Total Weight Gain (lbs) During Sudy	66	82	17	64	200	32	47	49	-16	49	66	98
Average Daily Milk Productivity (lbs)	49	49	37	43	52	69	56	54	41	48	52	47

* ND = Not Determined.
Control animals were fed with the herd

There did not appear to be any significant differences in changes in body weights for the two groups (see Table II-5). Eleven out of twelve cows gained weight and one Control animal lost a slight amount of weight (16 lbs). Overall, the Test group favored better by gaining 461 lbs, an average of 77 lbs/cow, while the Control group gained 293 lbs, an average of 49 lbs/cow. It should be noted that four (4) cows were early pregnant in the Test group and two (2) cows were pregnant in the Control group. This may account for some of the total weight differential between the two groups.

Average daily milk production for both groups illustrated by Figures II-3 and II-4, demonstrates no significant difference between the Test group and Control group. There was more variability in daily milk production for the Control group due to the fact that three Control animals had to be separated from the herd for medication due to a bad quarter. The three cows were medicated five (5), seven (7), and twelve (12) days respectively resulting in decreased milk production for these animals during these days (see Dairy Data Sheets in Appendix E). No animals in the Test group had to be separated as all Test cows maintained steady milk production. Table II-6 presents the daily milk production for each group. Total weight of milk produced by the Test group during the study was

9,760 lbs, while the Control group produced 7,732 lbs of milk during the study. This total milk weight difference (2,028 lbs) between the two groups is only partially explained by the reduced milk production of the three animals which had to be medicated. If these cows had maintained steady production in the Control group, only 300 - 400 lbs would be gained for comparison to the Test group. While there are no statistically significant differences between the two groups, the Test group appears to have performed better. Figures II-6 through II-11 are provided to illustrate individual dairy cow performance with respect to early milk production. These graphs again illustrate the greater variability of daily milk production for the Control group as compared to the Test group.

TABLE II-5. DAIRY FEED TRIAL INDIVIDUAL ANIMAL WEIGHTS.

	Test Group (Hyacinth)						Control Group (Standard)					
Cow ID #	73	189	209	242	374	508	29	105	197	278	367	369
Dec 9, 1987	1321	1288	1206	1142	1137	1468	1531	1419	1419	1403	1321	1190
Dec 28, 1987	1435	1321	1174	1223	1288	1484	ND	ND	ND	ND	ND	ND
Jan 12, 1988	1387	1370	1223	1206	1337	1500	1546	1468	1403	1452	1387	1288
Net Gain/(Loss)	66	72	17	64	200	32	47	49	(16)	49	66	98
Pregnancy	+	+	+	-	+	-	-	-	-	+	-	+

* All cows examined December 9, 1987

FIGURE II-3. DAIRY FEED TRIAL
AVERAGE MILK PRODUCTION (LBS)

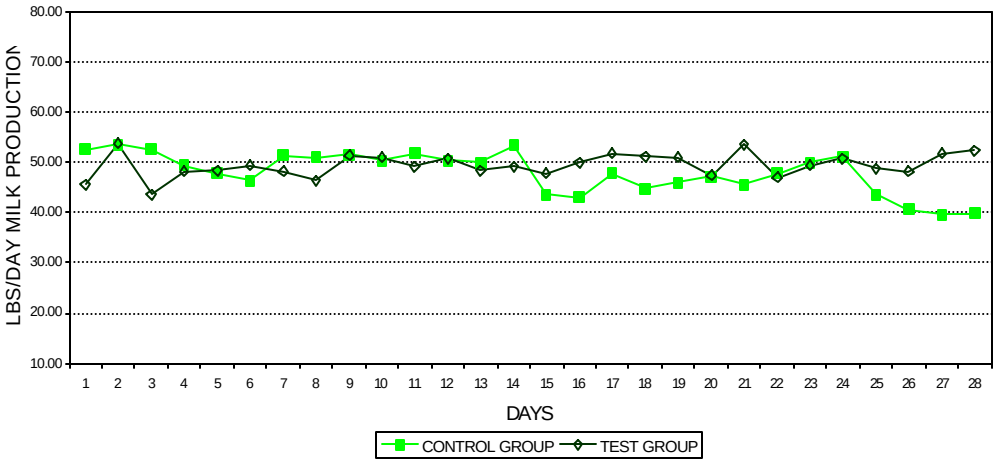


FIGURE II-4. DAIRY FEED TRIAL
4-DAY MEANS OF DAILY MILK PRODUCTION

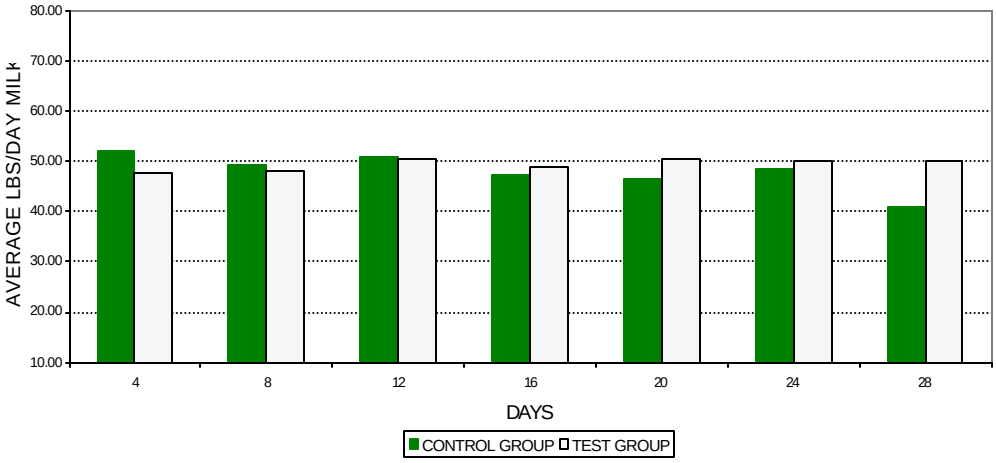
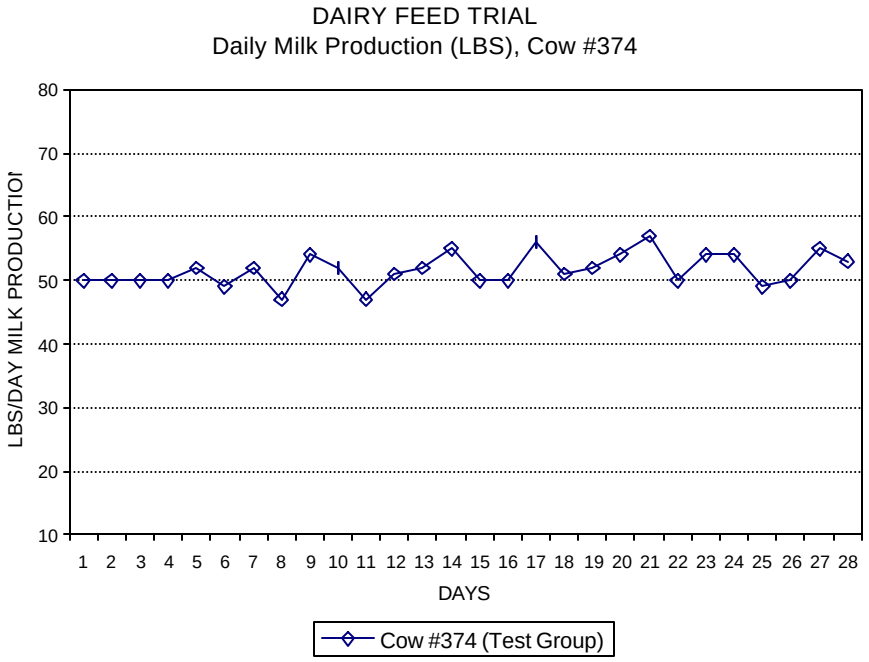


TABLE II-6. AMASEK FEED TRIAL MILK PRODUCTION CONTROL VERSUS TEST GROUP.

	Control Group (Standard) (lbs per day)						Test Group (Hyacinth) (lbs per day)					
Cow ID #	29	105	197	278	367	369	73	189	209	242	374	508
Days												
1	55	58	50	51	51	50	44	46	38	44	50	52
2	60	45	49	56	60	51	52	58	41	45	50	77
3	58	56	44	50	54	54	50	36	24	41	50	61
4	54	50	42	53	50	47	43	47	39	40	50	70
5	54	44	41	50	49	49	53	41	32	41	52	72
6	56	50	42	44	43	44	49	52	38	40	49	69
7	61	56	42	42	61	46	47	49	34	38	52	69
8	52	53	52	50	55	44	46	53	37	38	47	58
9	57	54	46	45	55	52	53	57	34	38	54	72
10	56	57	50	50	56	34	52	58	42	43	52	59
11	64	60	45	48	56	38	51	44	38	44	47	71
12	60	58	46	44	54	40	49	45	41	44	51	75
13	60	60	37	50	46	47	54	39	36	43	52	67
14	62	62	40	52	58	46	50	41	37	40	55	72
15	58	57	33	30	49	35	50	34	36	43	50	74
16	54	58	30	18	52	46	50	42	37	46	50	75
17	56	61	24	43	53	50	49	48	41	46	56	71
18	51	62	20	44	49	43	47	55	40	44	51	70
19	53	59	22	43	54	45	47	54	40	44	52	69
20	58	60	23	41	51	50	45	43	36	42	54	65
21	51	59	26	42	50	46	52	52	41	43	57	77
22	56	57	29	48	50	47	48	47	38	40	50	59
23	54	61	26	53	53	53	41	53	39	43	54	66
24	57	59	37	52	52	50	47	53	40	40	54	71
25	57	53	38	18	48	48	48	49	32	50	49	65
26	51	35	37	17	54	50	47	55	28	38	50	71
27	53	37	29	17	51	51	49	54	37	46	55	70
28	51	39	35	17	49	48	50	53	37	47	53	74
Total Lbs	1569	1520	1035	1168	1463	1304	1363	1358	1033	1191	1446	1921

FIGURE II-6. DAIRY FEED TRIAL



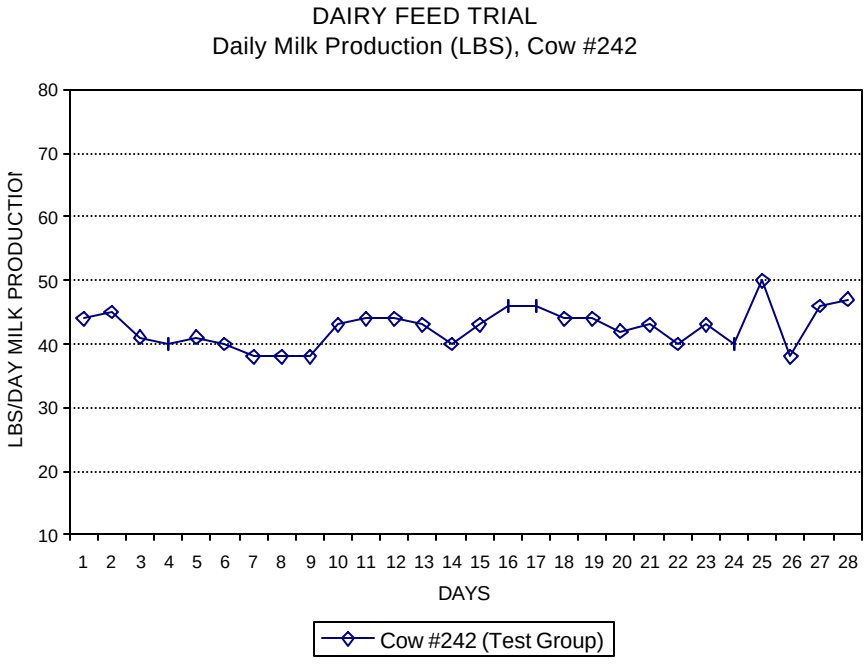
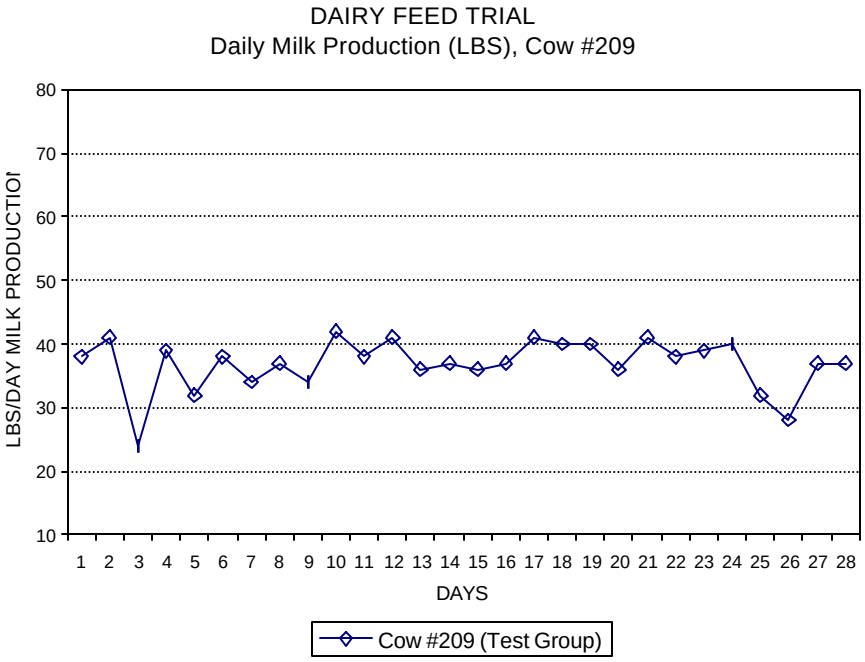


FIGURE II-7. DAIRY FEED TRIAL



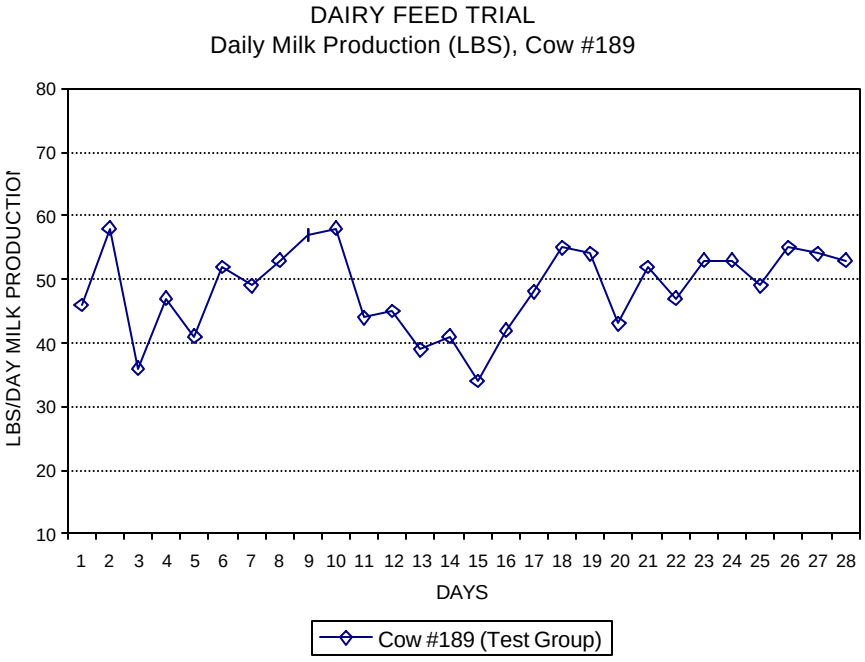
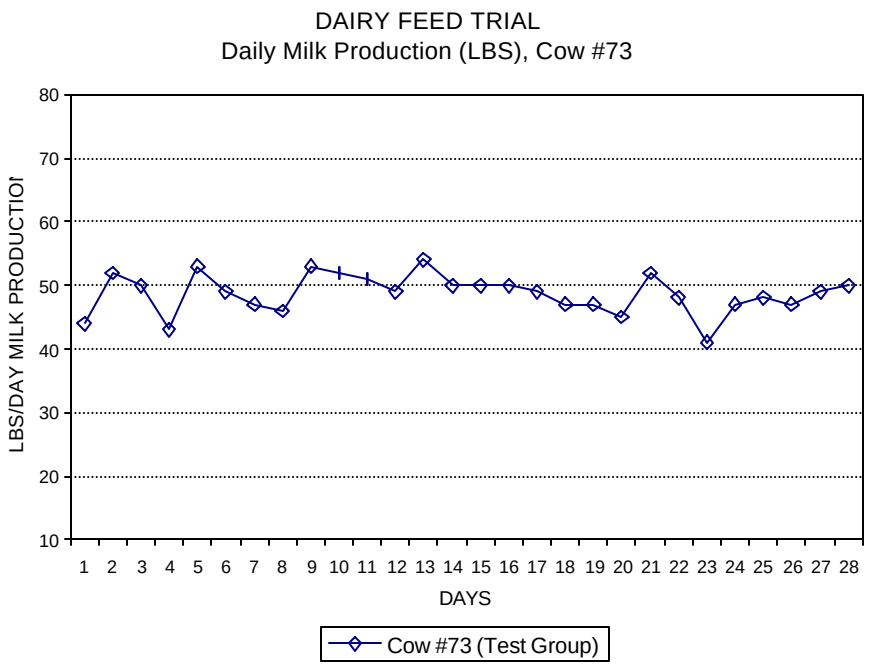


FIGURE II-8. DAIRY FEED TRIAL



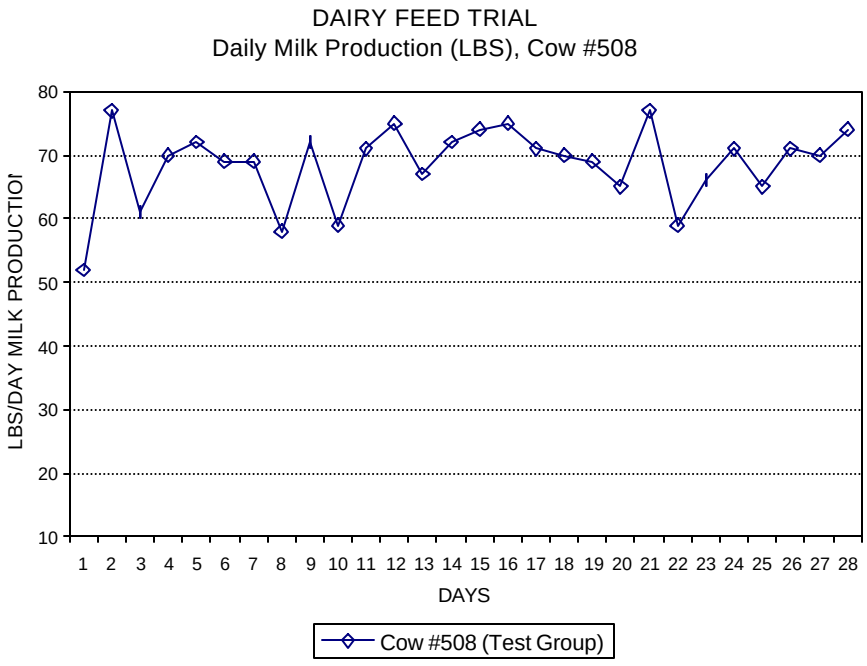
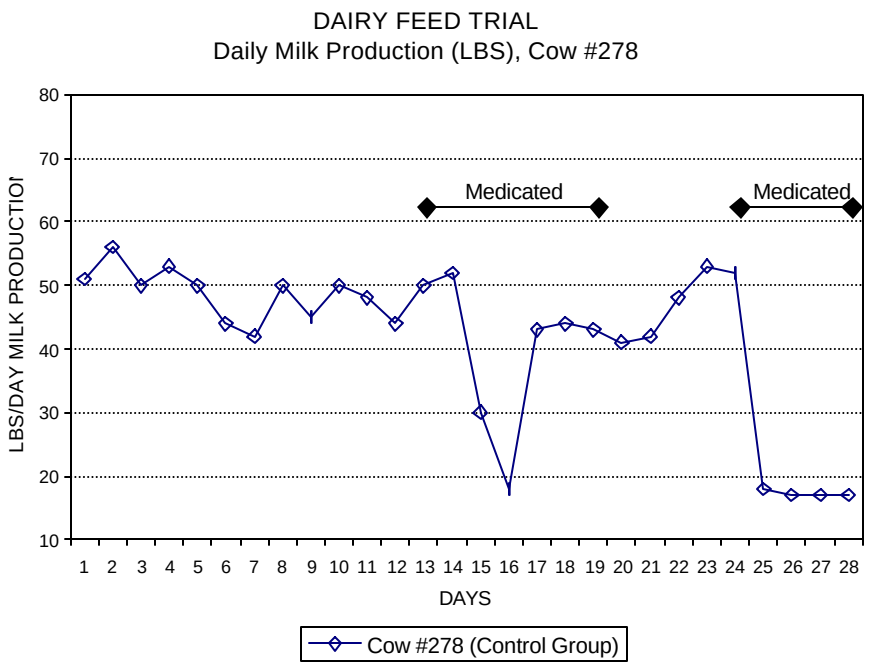


FIGURE II-9. DAIRY FEED TRIAL



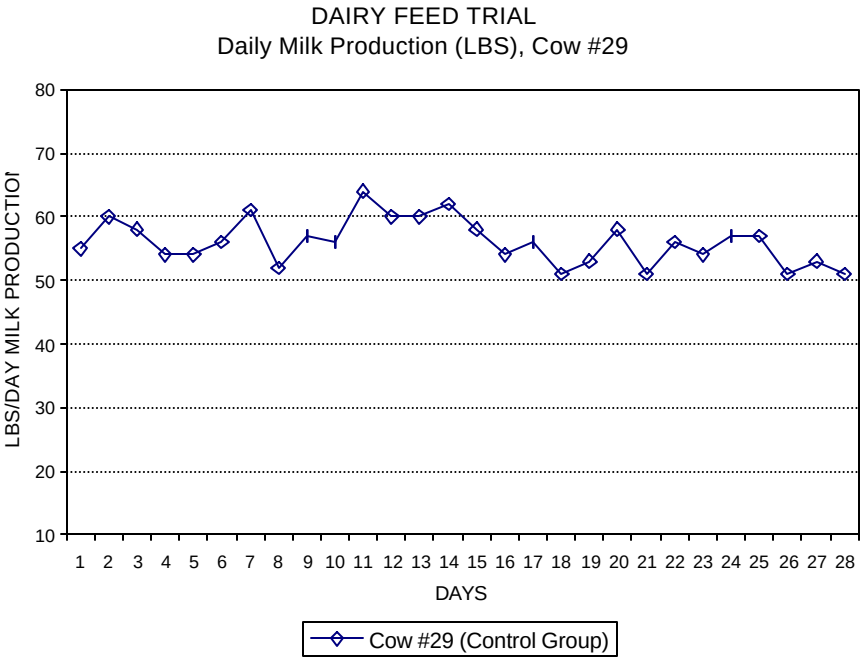
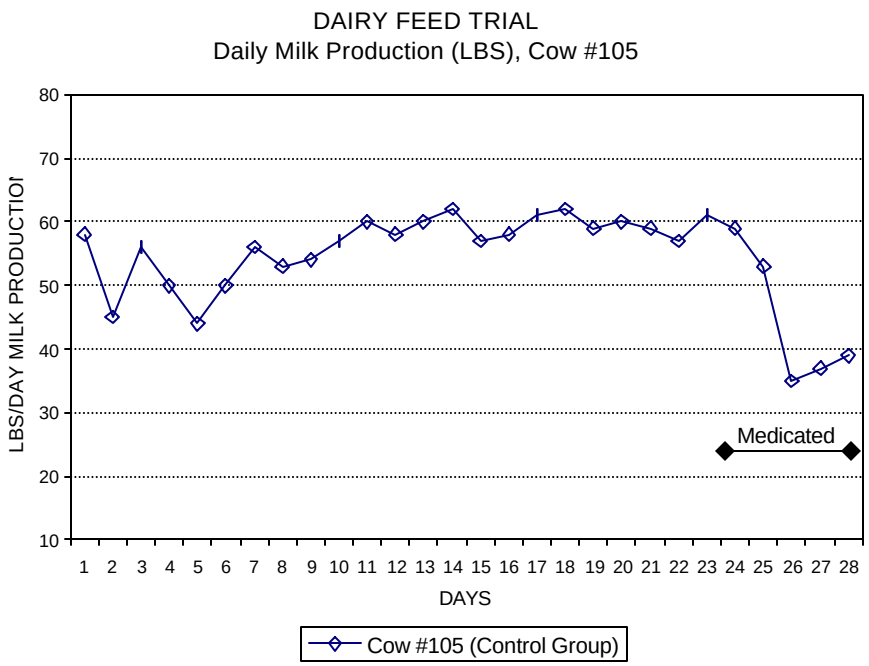


FIGURE II-10. DAIRY FEED TRIAL



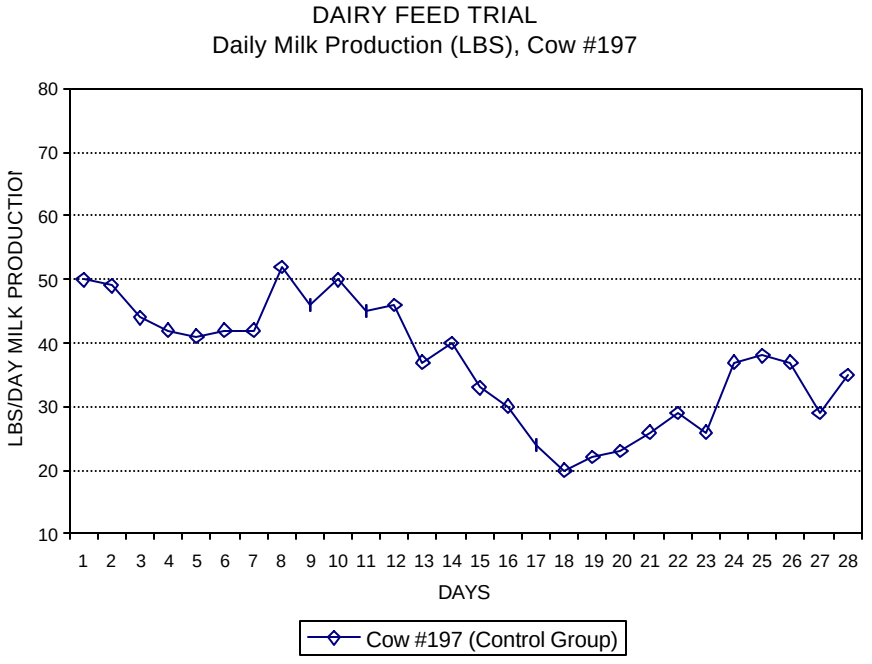
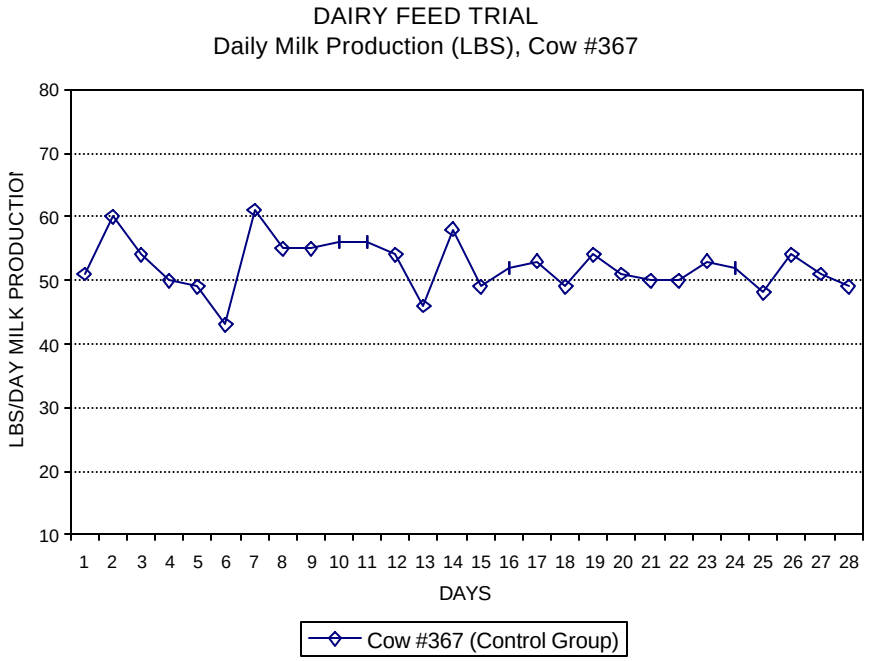
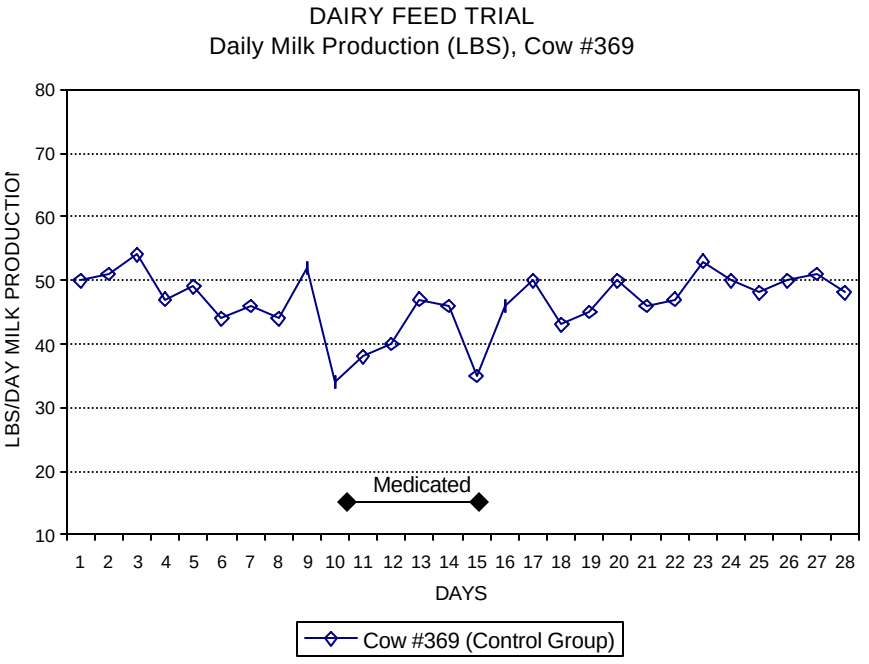


FIGURE II-11. DAIRY FEED TRIAL



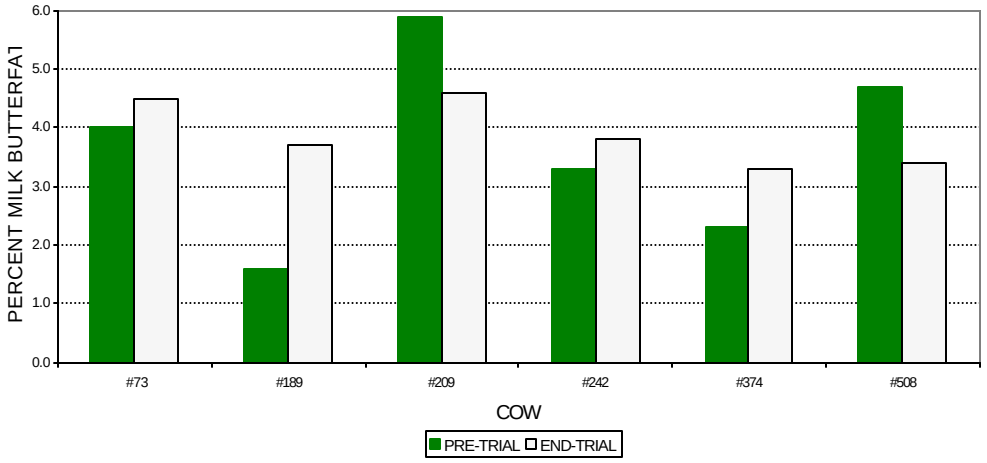


Daily milk production was recorded for both groups for five (5) days prior to initiation of the feed trial. Using this five-day period as baseline, comparisons were made with trial period production (Table II-7). In the Test group, three individuals decreased milk production by 4 lbs/day when the pre-trial average was compared to the 28 day trial average. In the Control group, four individuals decreased milk production by 3 lbs/day pretrial versus trial average. Increases in milk production were demonstrated by two individuals in the Test group, increasing an average of 4.8 lbs/day, and two individuals in the Control group, which averaged 1.8 lbs/day increase. One individual in the Test group, # 73, maintained that same average milk production. As previously stated, daily milk production for the two groups was not significantly different.

Table II-7 also presents that percent milk butterfat which was measured on 12/8/87 and 1/11/88 for the Test group and 12/8/87 for the Control group. Samples were collected on 1/26/88 from the Control group but were never reported by the Dairy Herd Improvement Association (DHIA) laboratory. Samples were either lost or overlooked and never analyzed. Therefore, we can only look at the Test group for beginning and end milk butterfat comparisons. Butterfat analysis is used as an indicator of milk quality and value. The industry standard is three (3) percent, below which the milk value is discounted, above which the milk value increases. The quality of fiber in the diet has been found to affect the amount of milk butterfat produced by dairy cows. Since the water hyacinth feed ingredient replaced cottonseed hulls as a fiber source, milk butterfat became an important parameter to measure the cows' utilization of the Test feed.

Prior to initiation of the feed trial, butterfat levels averaged 3.6% for the Test group and 3.07% for the Control group. Average butterfat increased for the Test group to 3.9% at the end of the trial. This indicated efficient utilization of the diet's fiber content and the consistent production of high quality milk. Figure II-5 compares the pre trial and trial period butterfat levels for each Test cow. Four of the six animals increased butterfat

FIGURE II-5. DAIRY FEED TRIAL
MILK BUTTERFAT CONCENTRATION (%) FOR TEST GROUP



production during the feed trial while two animals showed decreases. The two decreases are of little significance considering that one cow was producing an excessive level of butterfat to begin with (5.9%), was pregnant, and decreased to 4.6% which remained the highest level of the group, and the other cow was the highest milk producer of the group (69

lb/day) and maintained an acceptable level of butterfat (3.4%) despite the stress of heavy production. The butterfat production of the Test group in itself indicated that there were no detrimental effects of the diet, which reduced milk quality.

TABLE II-7. DAIRY FEED TRIAL. INDIVIDUAL PERFORMANCE
PRE TRIAL AND TRIAL PERIOD

Cow Identification (#)	Pre-Trial Milk Production 5-Day Avg. (lbs/day)	Trial Average 28-Days (lbs/day)	Pre-Trial Butterfat (Percent %)	End-Trial Butterfat (Percent %)
		Test Group		
73	48.6	48.6	4.0	4.5
189	52.0	48.5	1.6	3.7
209	43.2	37.4	5.9	4.6
242	45.2	42.5	3.3	3.8
374	48.4	51.6	2.3	3.3
508	62.2	68.6	4.7	3.4
		Control Group		
29	59.0	56.0	3.0	NA
105	53.0	54.3	3.9	NA
197	45.8	41.2	2.4	NA
278	51.2	47.9	3.5	NA
367	50.0	52.3	3.2	NA
369	48.4	46.6	2.4	NA

* NA = Not Applicable

Animal health evaluations were conducted by Dr. Brian McAdams, D.V.M. of Suwannee Oaks Animal Clinic, O'Brien, Florida. His complete report, which contains fecal analysis and blood chemistry, is included in this report as Appendix F. His report can be summarized as follows:

Initial evaluation indicated that cows were in good condition typical of lactating cows with no signs of disease. During the trial period there did not appear to be much difference between the Test and Control groups. Rectal temperatures were normal. Blood counts were all within normal ranges. There was not a significant change in blood analysis during the Test period for either group. Fecal exams showed both groups to be free of parasites with an insignificant number of ova noted. Blood serum analysis (data contained in Appendix F) identified high levels of the enzyme LDH. It is the veterinarian's opinion that the levels found may be typical of dairy cows due to the stress they experience during lactation. Other parameters such as Total Protein, Bilirubin, BUN, etc., were normal. Reproductive exams determined the animals to be normal for their respective stage of lactation. One cow in each group was diagnosed pregnant upon initial examination and maintained pregnancy through the study. Three other cows in the Test group, which were early pregnant were identified in the final exam. One other Control cow was diagnosed pregnant in the final exam. The fact that four out of the six Test cows maintained

pregnancy through the trial period indicated that there were no detrimental effects of the Test feed.

Dr. McAdams' conclusion of the study was that there was nothing that would indicate that the Test Group declined in health during the test period, and in fact a few parameters (i.e. reproduction) fared better than the Control.

SUMMARY

Results of the Dairy Feed Trial indicate that a ten percent Hyacinth feed blend is palatable and provides sufficient nutrients and fiber to maintain the health of the animal and production of high quality milk during the course of the study.

Results of health examinations and blood serum analysis indicated that there was no decline in the health of the Test group during the study period. Four pregnant cows in the Test group, which maintained pregnancy was a positive note, indicating no detrimental effects of the test feed.

There were no significant differences in daily milk production for the two groups. However, the Test group produced a greater quantity of milk over the period.

Three Control animals had to be medicated and separated from the herd for several days due to infection in one quarter, resulting in reduced milk production. All Test animals maintained steady milk production. No Test animal required medication.

Total weight gain was greater for the Test group. This may have been due to the fact that four of the six animals were pregnant, opposed to two of the six in the Control group.

The Test animals reduced their feed consumption an average of ten percent towards the end of the trial period (feed consumption could not be measured for the Control group). The reduction in feed intake may have been an indication that the animals' nutritional requirements were satisfied at the lower quantities.

Average milk butterfat values for the Test group increased during the feed trial. This indicated that their diet contained sufficient high quality fiber as provided by the replacement of cottonseed hulls with the hyacinth ingredient.

Considering the fact that the Test group exhibited weight gain, steady milk production, increased butterfat levels, good health, maintained pregnancy status, while reducing feed intake, supports the value of a ten percent hyacinth feed ingredient. These positive results support the extension of a dairy feed trial for 6-10 months to confirm trends and allow for a better economic evaluation of hyacinth feed production.

PRODUCT VALUE AND ECONOMIC CONSIDERATIONS

The replacement and adjustment of certain feed ingredients with water hyacinths in the dairy feed blend allowed for the estimation of the hyacinth product's value. In the dairy feed test blend, cottonseed hulls were totally replaced and adjustments in the quantities of soybean hulls, soybean meal and ground corn meal were made in order to balance nutrients with the standard feed. Below are the percent of total feed adjustments and the current market value per ton of each ingredient and resulting value of the 10% hyacinth ingredient:

	Percent Adjustment (%)	Market Value ($)	10% Hyacinth Value ($)
Cottonseed Hulls	-5.8	70.00	+4.06
Soybean Hulls	-4.5	82.50	+3.71
Soybean Meal (48)	-0.56	230.00	+1.29
Ground Corn Meal	+0.86	88.00	-0.76
Total			8.30

The ten percent hyacinth ingredient value is calculated at $8.30. Based on current market prices, 100 percent hyacinth material is valued at $83.00 per ton.

Laboratory analyses of the hyacinth feed material have indicated that hyacinths approximate Alfalfa Hay and Coastal Bermuda Hay on a nutritive basis. Considering current market value of these ingredients, hyacinths would be valued at $150 and $72 per ton respectively, based on a complete replacement by hyacinths. Therefore, current estimated value of hyacinth feed ranges from $72.00 to $150 per ton.

The hyacinth feed production on the limited scale, to supply the quantities desired for the initial test feeding, indicates the absolute need to be in a sustained production mode for an acceptable cost basis. Monthly operational costs for the treatment, harvesting and limited feed supplement production (1,000 lbs) were $5,685.40. Applying a monthly earned income credit for the treatment process ($3,800.00) to the experienced cost, the net chargeable to the limited feed production was $1,885.4O.

Based upon 1,000 lbs per month the cost value, as expected for a limited prototype production was $3,770.80 per ton. Actual production capacity, based upon 500 lbs per day from this facility, on a five day per week operational mode, would produce a cost reduction to $359.12 per ton of feed supplement.

The economic feasibility of the production of a supplemental feed from the hyacinth can best be currently described as falling into standard of “Economics of Scale,” with earned credit efforts from applicable sewage treatment processes. The initial feed test results with the potential market value of the product when coupled with the concept of wastewater treatment benefit and reuse of a resource is deemed most encouraging.

As Phase II of the feed trial Program continues, the additional quantitative values and attendant cost will assist in defining the highest and best use of harvested hyacinths for feed supplements.

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