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SUSTAINABLE AGRICULTURE RESEARCH AND EDUCATIONAL PROGRAM AND AGRICULTURE IN CONCERT WITH THE ENVIRONMENT

1. FINAL REPORT

2. DATE OF REPORT: January 22, 1993

3. PROJECT TITLE: The Integration of Crop (Potato) and Livestock Production Systems

4. PROJECT STATUS: N/A

5. PROJECT COORDINATOR: Dr. R.L. Hough
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6. MAJOR PARTICIPANTS: No Change

7. COOPERATORS: No Change

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12. OBJECTIVES: No Change

13. PROJECT RESULTS:

A. Findings:

Technology Transfer

An aggressive technology transfer program was initiated during the summer of 1990. A variety of programs are underway or have been completed at this time under the leadership of the University of Maine Cooperative Extension with the support of LISA funds. These programs include a variety of educational methodology including handbooks, fact sheets, popular press, seminars, field days, conferences and direct producer contact. They have been on various subjects including facilities, by-product feeding, utilization of small grain rotational crops, marketing, cold weather management, starting feeder cattle in the feedlot, feeding strategies and enterprise management. A further explanation of specific programs are listed below:

1. **Direct Producer Contact** Fifteen operating and start-up feedlots were selected for enhanced technical support.

The basis for this program has been a series of nine mailings to date written by leading authorities on different aspects of feedlot management. To support this effort, the entrepreneurs are contacted regularly by phone to explain various aspects of the information presented. Thirteen of the feedlots have also had a minimum of one visit by the Extension Livestock Specialist and the remaining two are scheduled for follow-up visits. At one 700 head feedlot the information provided has assisted in decreasing death loss from 5% to 1.1%. Joe Connors, the 1988 New Brunswick Farmer of the Year, discussed the management practices employed on his stocker operation at the 1990 Beef Conference to help support this educational effort.

2. **Facilities** Three consulting feedlot engineers from Iowa State University have been contracted to recommend facility designs and sighting considerations to minimize environmental impact. They have visited Maine and provided us with blueprints of their recommended designs. Two of these structures are being completed at this time. They have also completed a preliminary report which is currently under review and scheduled for publication. The environmental engineer, Dr. Stew Melvin, has presented the recommendations at our annual beef conference held on Dec. 1, 1990.

3. **By-product Feeding** An extensive review of the literature has been completed resulting in a series of seminars and field days being conducted statewide on the utilization of by-product feeds with the focus on potato by-products. This includes eight local meetings, presentations at Small Farm Field Day and Aroostook Experiment Station Field Day, segments WERU radio and WAGM-TV, Potato Pickers Special, and numerous farm visits. Presentations were given at the Aroostook Beef Conference and Potato Conference concerning the use of cull potatoes for silage. A field day was conducted at a farm that demonstrated the technology. This program has greatly increased the demand for potato by-products and the understanding by producers on how to incorporate it into their rations.

4. **Marketing** A program was conducted to inform feedlot managers of their marketing options. This involved touring five of these individuals to major packing plants in New Brunswick and Pennsylvania. This allowed them to gain an understanding of the differences between the USDA and Canadian grading systems to facilitate the marketing of different types of cattle at optimum value. They also had the opportunity to meet the cattle buyers from these plants. The results of this tour were presented at the 1990 Beef Conference by Dr. Robert Hough.

5. **Cold Weather Management** A program was recently started to inform producers on winter management and the effects of cold stress on cattle. Dr. Bruce Young from the University of Alberta spoke on this topic at the 1990 Beef Conference which was attended by 235 producers. This program was continued with a series of local seminars.

6. **Small Grain Feeding** Maine potato producers have traditionally marketed small grains grown in rotation at below break even prices to out-of-state markets. To encourage the feeding of local grains, a series of educational programs are being implemented. They have focused on local meetings to inform dairy and livestock producers on how to incorporate these grains into rations and the logistics of purchase. This ongoing program has resulted in barley production being increased from a few hundred acres to over 21,000 acres.

7. **Feeder Calf Supply** Local meetings, work shops, farm visits, fact sheets and the Beef Conference have been utilized to help make feeder calf production more profitable and reliable. This program is ongoing and will cover all aspects of beef cattle management. One of the major efforts has been two feeder calf sales started in 1988 with under 200 head. The 1992 sales resulted in over 1500 head being marketed. This management and marketing program contributed to the 7,000 head increase in Maine's beef cow herd reported by the USDA in 1990. This has also allowed feedlots to purchase uniform groups of cattle and moved us closer to the critical mass necessary for a profitable industry.

8. **Farm Management** Farm management was featured at our 1991 Beef Conference. Featured on the program was Dr. Dan Fox from Cornell, Guy Hutt from Wolfe's Neck Farm and Ross Proctor, Ontario Farmer of the Year. We have implemented the Cornell Beef Farm Financial Record keeping system on 62 farms. We will be gaining the results from this in 1993.

Research

See Attached Article

C. Case Studies: N/A

D. Economic Analysis:

We distributed 62 Cornell Beef Farm Financial Record

Keeping Books for fiscal year 1992. We have not summarized this data at this point.

E. Dissemination of Findings:

Publications:

Hough, R.L., D.M. Potter and M.S. Williams. 1993. Compatibility of feedlots with potato operations. In: S.B. Johnson (Ed.). Eighth Annual ME Potato Conf. Proc. 8:32. Univ of ME. Coop. Ext., Orono.

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Hough, R.L. 1990. The impact of livestock development on feed grain production and marketing in Maine. In: E. Plissey (Ed.). Fifth Annual ME. Potato Conf. Proc. 5:20. Univ. of ME. Coop. Ext., Orono.

Hough, R.L. 1990. Preconditioning feeder cattle. Coop. Ext. Publ. No. 2217. Univ. of ME., Orono.

Hough, R.L., D.D. Stimpson, H.C. Gibbs and A.R. Corey. 1990. Management of newly arrived feedlot cattle. Coop. Ext. Publ. No. 2218. Univ. of ME., Orono.

Melvin, S.W. and D.S. Bundy. 1990. Beef feedlot facilities for feeding potato processing wastes. Report. Univ. of ME. Coop. Ext., Orono.

Extension Activities for the LISA Project:

Potato Byproduct and Rotation Crop Utilization

July 19, 1990 Aroostook Experiment Station Field Day
Title:Feeding Cull Potatoes
Attendance: 75

July 28 Small Farm Field Day

Title:By-product Feeding
Attendance: 60

Sept. 24 Franklin Co.
Sept. 25 Oxford Co.
Title:Feeding Barley
Attendance: 42

Sept. 28 WAGM, Potato Pickers Special
Title:The Maine Livestock Industry

April 6, 1991 Aroostook Co. Beef Conference
Title:Feeding Cull Potatoes
Attendance: 68

Aug. 21 Fort Kent
Title:Feed Alternatives
Attendance: 16

Oct. 25 WERU, Living on a Few Acres
Title:Managing Your Feed Inventory

Jan. 9, 1992 Seventh Annual Maine Potato Conference
Title:Potato Silage as an Alternative Cull Disposal Method
Attendance: 280

Mar. 21 Aroostook Co. Beef Conference
Title:Potato Silage
Attendance: 70

June 6 Aroostook Co.
Title:Pasture Management Field-Day
Attendance: 32

August 13 Fort Kent Field-Day
Title: Potato Silage
Attendance: 40

Jan. 7, 1993 Eighth Annual Maine Potato Conference
Title:Compatibility of Feedlots with Potato Operations
Attendance: 150

Sustainable Agriculture

Oct.19, 1990 Franklin Co. Annual Farm Bureau Meeting
Title:Environmental Issues Facing Agriculture
Attendance: 72

Dec. 1 Third Annual Beef Conference
Title:Managing a Diversified Farm
Attendance: 235

Apr.27, 1991 Maine Beef Expo.
Title:Beef Cattle Efficiency
Attendance: 30

Feb. 9 Heifer Project International Annual Meeting
Title:Beef Cattle in Maine
Attendance: 35

March 21 Sustainable Agriculture Shortcourse
Title:Animal Agriculture
Attendance: 58

Dec. 7, 1992 Fourth Annual Beef Conference
Title:Beef Marketing Trends and Implications
Title:Integrated Resource Management
Title:IRM at Wolfe's Neck Farm and Maine
Title:Developing Heifers: Critical Issues
Title:Managing for Profit
Attendance: 175

Maine Beef Cattle Winter School

Oct. 9, 1990 Newport
Oct. 10 Hancock Co.
Oct. 11 Cumberland Co.
Nov. 12 Franklin Co.
Nov. 13 Houlton
Nov. 14 Presque Isle
Nov. 15 Fort Kent
Title:Fall Beef Cattle Management
Attendance: 120

Jan. 24, 1991 Houlton
Jan. 28 Franklin Co.
Feb. 19 Hancock Co.
Feb. 20 Presque Isle
Feb. 21 Fort Kent
Mar. 5 Oxford Co.
Title:Managing Beef Cattle in Cold Environments
Attendance: 95

March 25 Franklin Co.
March 26 Hancock Co.
Title:Spring Management
Attendance: 33

Marketing Beef Cattle

Aug.20, 1990 Franklin Co. Beef Producers
Title:Preconditioning Feeder Cattle
Attendance: 24

Dec. 1 Third Annual Beef Conference
Title:Marketing Beef Cattle
Attendance: 235

WERU, Living on a Few Acres
Oct. 25 Title:Marketing Feeder Cattle
Mar.28, 1991 Title:Marketing Livestock
July 25 Title:Feeder Cattle Grading

Aug. 5 Freeport
Aug. 6 Farmington
Aug. 6 E. Corinth
Aug. 7 Presque Isle
Title:Feeder Cattle Marketing
Attendance: 260

Oct. 10 Presque Isle
Title:Preconditioning Feeder Cattle
Attendance: 28

Livestock Facilities and Housing

Dec. 1, 1990 Third Annual Beef Conference
Title:Practical Beef Cattle Facilities
Title:Managing Beef Cattle in Cold Environments
Attendance: 235

Dec. 27 WERU, Living on a Few Acres
Title:Winter Management

Jan. 7, 1991 Houlton
Jan. 8 York Co.
Title:Livestock Handling Facilities
Attendance: 40

Feb. 28 WERU, Living on a Few Acres
Title:Preparing for Calving and Lambing Season

April 13 Aroostook Co. Livestock Field Day
Title:Tour of Low Cost Livestock Facilities
Attendance: 50

Feb. 6, 1992 New England Beef Council Annual Meeting
Title:Cold Weather Management
Attendance: 55

E. Producer Involvement

Workshops	593
Conferences	1,033
Field Days	517

14. POTENTIAL CONTRIBUTIONS AND PRACTICAL APPLICATIONS

The Maine beef industry has doubled in size since 1988 and has increased the return to this state's economy by over $11 million annually. This viability has and will continue to place a demand for rotation crops and potato by-products. This favors the practice of rotation with the long range implications of increased potato quality and decreased need for pesticides due to disease interruption.

15. AREAS NEEDING ADDITIONAL STUDY: N/A

The effect of dry matter level and type of storage on quality parameters and effluent loss of potato based silage

R.L. Hough, M.H. Wiedenhoeft, B.A. Barton and A.C. Thompson, Jr.

ABSTRACT

Potato by-products represent a significant ruminant livestock feed resource in potato growing regions. Three studies were conducted to determine the effect of dry matter (DM) and storage system on silage quality and effluent loss of potato silage. The storage treatments were either: contained system (CS) or a system where effluent was allowed to escape (ES). Dry matter treatments (hay addition on a wt:wt basis) were: 1) 100 % potato; 2) 92 % potato: 8 % hay; 3) 85 % potato: 15 % hay; and 4) 77 % potato: 23 % hay. The ES silage had a higher pH than CS indicating enhanced fermentation in the contained system. Dry matter also affected pH with treatment 1 having the highest and treatments 3 and 4 the lowest pH at day 60. However, treatment 4 had the slowest decline in pH through the second week of the trial. Ash content was lower in ES than CS. Ca, P, K and CP were generally higher in CS than ES with a significant interaction between DM and storage treatment. Cumulative effluent losses represented 45.5, 15.5, 9.2 and 1.2 % of the initial weight. Effluent losses in the ES system for treatment 1 represented an excessive loss of nutrients.

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INTRODUCTION

The basic premise of animal agriculture is to utilize feedstuffs, such as forages, surplus grains and by-products, which can be value-added as livestock feed to produce useful products such as milk, meat, wool and hides. The feeding of by-products from agricultural and non-agricultural industries not only offers livestock operations valuable opportunity feeds, but also helps alleviate the economic and environmental burden of disposal for the parent industry (Hoover, et al., 1976; Stanhope et al., 1980; Hough, 1990).

Consistency in the diet of ruminant livestock is necessary for optimum performance to be realized. This can be difficult to obtain when potato by-products (such as cull potatoes) are included in a diet, because they are usually available in varying quantity and quality throughout the calendar year. Also, it is important that the livestock entrepreneur be a reliable receptor of these products for the industry producing them. Thus a method of inventorying a by-product becomes critical.

The typical methods of producing a potato by-product inventory include drying, slurry and silage (Dickey et al., 1974; Hinman and Sauter, 1978; Sauter et al., 1979; Nicholson et al., 1982). Dehydration is not desirable due to high energy costs and the reduction in crude protein (CP) digestibility (Nicholson, 1974). Slurry is an accepted and useful method of inventory; however, cold weather handling and the accumulation of toxigenic bacteria, mycotoxins and objectionable odors can be a problem (Sauter et al., 1980). Silage has the advantage for many livestock operations in northern climates in terms of material handling and fitting into existing management and facilities. However, spoilage of the silage and environmental impact from effluent can become a problem with a silage system (Allender, 1948; Remillard, 1978). Therefore, these experiments were designed to evaluate dry matter (DM) and storage system on potato based silage quality and nutrient loss.

MATERIALS AND METHODS

Three studies were conducted to determine the effect of dry matter level and storage type on quality and fermentation parameters of potato based silage. Chopped grade B round white potatoes where utilized for all experiments and DM was altered by the addition of low quality first cut mixed grass hay that was chopped to approximately 5 cm in length. Composition of the parent herbage utilized for the experiments is shown in Table 1.

Experimental potato and hay herbage were mixed thoroughly and compressed into the silos. All herbage was weighed prior to ensiling. Laboratory silos constructed of 15.24 x 76.20 cm plastic pipe that was fitted with two end-caps were utilized for the trials. A fermentation lock was installed at the top of each silo to allow for the escape of gasses produced by fermentation. The silos were sealed with silicone caulking compound to prevent seepage of liquids and to make an air tight seal. All silos were maintained in a similar controlled environment at 22°C.

Experiment 1

A 60 d factorial study was conducted as a completely randomized design to determine the effect of dry matter level on fermentation characteristics over time in a contained storage system. Dry matter treatments, derived from the addition of hay on a wt:wt basis, and the predicted DM were: 1) 100 % potato, 18.8 % DM; 2) 92 % potato: 8 % hay, 24.7 % DM; 3) 85 % potato: 15 % hay, 30.0 % DM; and 4) 77 % potato: 23 % hay, 36.0 % DM. Termination times were day 7, 14, 21, 30 and 60 with three replications for each period for a total of 60 silos. At each time, pH of a representative fresh sample was determined utilizing an Orion Research model 701 pH meter. ANOVA was performed to determine difference in treatments, times and interactions. Means were separated utilizing Fisher's Protected Least Significant Difference values (SAS, 1985).

Experiment 2

A 54 d trial consisting of repeated measures in a completely randomized design was conducted to determine the volume and nutrient loss resulting from seepage from potato based silages of varying dry matter levels. Dry matter treatments and parent mixtures were the same as experiment 1. However, a 1.5 cm diameter pipe was installed in the bottom cap to allow effluent to escape from the silage. Glass wool was placed in the bottom of each silo before packing to prevent blockage of the outlet tube. Runoff was collected in plastic jugs. Weight and volume of the effluent was measured daily for the first two weeks and every other day until day 54. Alloquats of the effluent were stored in sealed jars at -20°C until analyses. Dry matter, ash and N were determined utilizing procedures in AOAC (1990). Organic matter (OM) was calculated as the difference between total DM and ash. Selected essential elements (Ca, Mg, K, and P) were analyzed for, after nitric and perchloric acid digestion, using an inductively coupled plasma emission spectrophotometer. Analysis of data was performed utilizing the General Linear Model procedure from SAS (1985). To determine when effluent loss had stopped for a segmented model, an analysis was conducted utilizing Non-Linear Regression Procedure (SAS, 1985).

Experiment 3

A 60 day study was conducted to determine the effect of DM and storage system on potato based silage quality. A 2 x 4 factorial with a completely randomized design with 3 replications was utilized. The storage treatments were either: contained system (CS) or a system where effluent was allowed to escape (ES). Dry matter treatments were the same as experiment 1. On day 60, silos were opened and a representative sample of the silage was obtained. The pH of the silages were determined on a fresh sample as previously described. Dried herbage was analyzed for: 1) total DM, CP and ash; 2) neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Goering and Van Soest, 1970); and 3) selected essential elements (Ca, Mg, K, and P). ANOVA was performed to determine differences in treatments and interactions. Means were separated utilizing Fisher's Protected Least Significant Difference values (SAS, 1985).

RESULTS AND DISCUSSION

Experiment 1

The pH over time for various dry matter treatments is represented in Table 2. On day 7, treatment 1, 2 and 3 had a lower pH than the highest dry matter treatment. This relationship numerically continued until day 14, and by day 21 a treatment x time interaction was observed ($P > .01$). On day 21, treatment 1 and 2 had the highest pH and on day 30 and 60 treatment 1 was the highest ($P < .05$). These results indicate that higher dry matter levels result in a slower decline in pH, but a lower pH over time.

The decline in pH was slower in the present study when compared to results from Sauter et al. (1979) who reported a decline in pH from 6.0 to 3.5 in 2 days for filter cake slurry. This low pH was maintained for the remaining 5 weeks of their study. In a subsequent study, Sauter et al. (1985) did not observe a difference in pH or volatile fatty acid concentration in silages with 5:1 or 4:1 potato processing waste to straw ratio. However, silages made from dry peal had higher butyric acid and lower lactic acid concentrations when compared to filter cake slurry. The pH values reported by Nicholson et al. (1982) for a 37 % DM silage mixture (3 parts potato to 1 part chopped hay, wt/wt) allowed to ferment at similar temperatures as the present study were higher at 4 and 8 weeks (5.3 and 5.0, respectively). Remillard (1978) ensiled potato-hay silage at high dry matters (46.38 to 47.59 % DM) and reported waste and mold in 17.1 to 35.3 % of the silage. These results are consistent with the present study in which higher DM resulted in slower decline in pH.

Experiment 2

The dry matter of the silage had a significant (P < .01) effect on the cumulative effluent loss over time (Figure 1). Effluent loss was greatest for treatment 1 and lowest for treatment 4. Cumulative effluent losses were 5.50, 1.42, 0.70 and 0.08 L for treatment 1, 2, 3 and 4, respectively, which represented weight losses of 45.5, 15.5, 9.2 and 1.2 %, respectively. The cumulative effluent loss did not significantly (P < .01) increase for treatment 1 after day 18 and day 50 for treatment 2. A plateau was not detected for treatment 3 and the cumulative effluent loss for treatment 4 did not differ significantly from zero.

The concentration of OM, N, Ca, P, Mg and K in the effluent increased as the dry matter of the silage increased; although, the total volume of effluent decreased (Table 3). This resulted in treatment 1 having the highest, treatments 2 and 3 intermediate, and treatment 4 the lowest loss of nutrients except for Ca (Table 4). This was due to the extremes in effluent volume for these treatments (450.6 vs 9.5 ml/kg silage for trt 1 and 4, respectively). However, there was no significant decrease in net loss of OM, N, Ca, P or Mg between treatments 2 and 3. For these treatments, the decreased concentration of the nutrients in the effluent was of significant magnitude to offset the volume differences.

Potato based silages have long been reported to have high losses if effluent is not contained (Allender, 1948). The data presented substantiates this observation, and demonstrates that 100 % potatoes, that are not stored in a contained system, can impact the environment through nutrient "run-off." Nicholson et al. (1982) produced potato silage with a 25 % addition of hay with satisfactory results. Hoover et al. (1976) utilized hay addition of 50 % and reported that silages were well preserved. However, Remillard (1978) observed high levels of spoilage with high dry matter silages. The present study indicates that there is no advantage to an addition of more than 23 % hay for silage preservation while minimizing effluent loss from potato based silage.

Experiment 3

The dry matter of the silage was higher in the ES compared to CS for treatments 1, 2 and 3 ($P < .01$). The magnitude of the difference between the systems (Table 5) increased as the percentage of potatoes was increased in the silage due to increased effluent loss. The storage system did not significantly affect the fiber of the silages (Table 5). However, the percentage difference of ADF between ES and CS numerically decreased when the percentage of DM increased (36.8, 18.6, 10.1 and -1.7 % for treatment 1, 2, 3 and 4, respectively). This difference would presumably be due to the loss of soluble carbohydrates and minerals in the effluent.

The ES silage had a ($P < .01$) higher pH than CS (4.26 vs 4.04) indicating enhanced fermentation in the contained system. Dry matter also affected pH (Table 5). In the ES, pH declined as DM increased; however, in the CS, no further decrease in pH was observed between the two highest DM levels ($P < .05$). Sauter et al. (1980) observed that the percentage of lactic acid increased when DM was increased from 31.4 to 36.4 %. However, further increases in DM did not result in further enhancement of lactic acid concentrations.

Ash content was (P < .01) lower in ES than CS (5.56 vs 6.51 %). Calcium, P, K and CP were generally higher in CS than ES with an interaction (P < .05) between DM and storage treatment (Table 5). This can be explained by the higher effluent loss of these nutrients (Table 4) in the lower DM treatments compared to the high DM treatments. However, crude protein was higher then predicted for treatments 1, 2 and 3 based on the parent herbage (Table 1) indicating the initial sample analyzed for N was unrepresentative. Loss of CP was observed in treatment 1 for both storage systems and resulted from effluent loss as well as possible volatilization of N during fermentation in the CS. Sauter et al. (1979) reported that losses during fermentation of 100 % potato waste in pit storage can be significant and recommended rapid turnover of inventory in these circumstances.

SUMMARY

Potato by-products can be successfully inventoried as silage for use as livestock feed. However, storage design and DM level has a significant impact on fermentation characteristics and nutrient loss of the silage. Excessive dry matter can result in a slow decline in pH and increases the risk of spoilage. However, too low a DM mixture can lead to excessive seepage and loss of nutrients. Storage design can influence the quality of potato based silage by reducing losses. The present studies indicate that addition of hay enhanced silage quality in both storage systems with dry matter requirements being higher to control seepage in systems where effluent is allowed to escape.

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Table 1. Chemical composition of potato and hay utilized for silage

Item	Potato	Hay
Dry matter (%)	18.8	93.8
	-------% of DM------	
Crude protein	10.62	6.88
ADF	7.42	40.57
NDF	11.24	68.95
Ash	7.43	5.00
Ca	0.04	0.40
P	0.16	0.19
Mg	0.26	0.19
K	2.50	1.37

Table 2. The pH over time of potato based silage at varying potato:hay ratios[1]

Item	Treatment[2]				
	100:0	92:8	85:15	77:23	SE
Day 7	4.47[b]	4.41[b]	4.50[b]	4.61[a]	.03
Day 14	4.15	4.14	4.08	4.24	.03
Day 21	4.22[a]	4.23[a]	4.10[b]	4.10[b]	.03
Day 30	4.25[a]	4.08[b]	4.03[b]	4.05[b]	.02
Day 60	4.17[a]	4.05[b]	3.94[c]	4.01[bc]	.03

[1] Means within a row with different superscripts differ ($P<.05$).
[2] Potato:hay ratio (wt:wt).

Table 3. Chemical composition of effluent from potato based silage at varying potato:hay ratios[1]

Item	Treatment[2]				
	100:0	92:8	85:15	77:23	SE
Organic Matter (ppm)	30,371.7[c]	35,873.5[c]	57,269.4[b]	81,581.3[a]	2,245.8
N (ppm)	163.0[b]	211.7[b]	334.8[a]	446.1[a]	23.8
Ca (ppm)	118.6[d]	823.6[c]	2,109.5[b]	4,293.5[a]	124.8
P (ppm)	1,610.8[d]	2,420.1[c]	3,517.8[b]	5,124.4[a]	125.2
Mg (ppm)	1,035.5[d]	1,795.6[c]	2,587.3[b]	4,377.2[a]	141.3
K (ppm)	17,820.0[d]	25,303.9[c]	30,958.5[b]	40,342.6[a]	1,486.5

[1] Means within a row with different superscripts differ ($P<.05$).
[2] Potato:hay ratio (wt:wt).

Table 4. Volume and nutrient loss of potato based silage at varying potato:hay ratios where effluent was allowed to escape[1]

Item	Treatment[2]				
	100:0	92:8	85:15	77:23	SE
Volume (ml/kg)	450.6[a]	141.7[b]	78.6[c]	9.5[d]	8.1
Organic Matter (mg/kg)	13,703.0[a]	5,100.3[b]	4,509.2[b]	775.5[c]	585.1
N (mg/kg)	73.5[a]	30.4[b]	26.4[b]	4.2[c]	4.7
Ca (mg/kg)	53.4[b]	117.4[ab]	166.7[a]	40.8[b]	23.9
P (mg/kg)	8.9[a]	3.5[b]	2.5[b]	0.4[c]	0.01
Mg (mg/kg)	467.5[a]	255.2[b]	204.2[b]	41.6[c]	29.6
K (mg/kg)	8,039.6[a]	3,595.7[b]	2,442.7[c]	383.5[d]	343.5

[1] Means within a row with different superscripts differ ($P<.05$).
[2] Potato:hay ratio (wt:wt).

Table 5. Effect of dry matter and storage type on chemical composition of potato based silage[1]

Item[3]	Treatment[2] CS-1	ES-1	CS-2	ES-2	CS-3	ES-3	CS-4	ES-4	SE
pH	4.17^{cd}	4.40^{a}	4.05^{b}	4.30^{ef}	3.94^{g}	4.23^{bc}	4.01^{fg}	4.11^{de}	0.03
DM	21.4^{f}	34.0^{bc}	25.8^{e}	30.0^{d}	28.7^{d}	33.0^{c}	36.2^{a}	35.5^{ab}	0.75
C.P.	9.69^{ab}	7.19^{cd}	11.15^{b}	10.10^{d}	10.65^{cd}	9.85^{e}	10.25^{a}	9.38^{bc}	0.19
NDF	5.90	6.77	35.14	36.38	41.24	47.05	52.24	51.11	3.57
ADF	3.75	5.13	18.54	21.98	24.68	27.17	30.08	29.57	2.07
Ash	5.81^{c}	4.62^{d}	7.15^{a}	5.89^{c}	6.70^{b}	5.79^{c}	6.39^{b}	5.93^{c}	0.13
Ca	0.04^{e}	0.03^{e}	0.17^{c}	0.14^{d}	0.24^{b}	0.19^{c}	0.30^{a}	0.24^{b}	0.01
P	0.23^{ab}	0.15^{d}	0.24^{a}	0.18^{cd}	0.23^{ab}	0.20^{bc}	0.23^{ab}	0.21^{abc}	0.01
Mg	0.11	0.08	0.17	0.16	0.20	0.14	0.20	0.17	0.01
K	2.03^{ab}	1.20^{e}	2.09^{a}	1.70^{d}	1.93^{abc}	1.76^{cd}	1.85^{bcd}	1.85^{bcd}	0.06

[1] Means within a row with different superscripts differ ($P<.05$).

[2] Treatment 1=100:0; 2=92:8; 3=85:15; 4=77:23 potato:hay ratio (wt:wt). Treatment CS=contained storage; ES=effluent escape storage.

[3] All items except pH and dry matter are expressed as a percentage of dry matter.

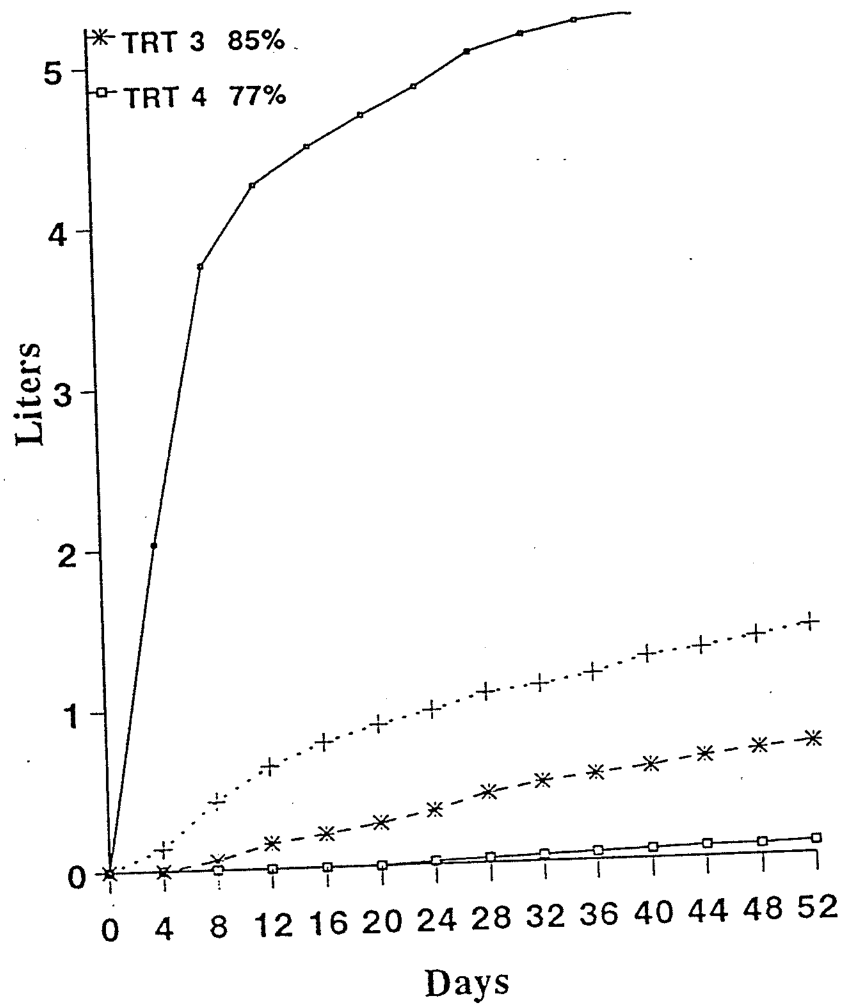

Figure 1. Cumulative effluent loss for potato based silage at 100:0, 98:8, 85:15, or 77:23 potato to hay ratio (wt/wt), SE = 0.09

COMPATIBILITY OF FEEDLOTS WITH POTATO OPERATIONS

by

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Part of managing a profitable potato enterprise can be feeding cattle as a component of the operation. Feedlot operations in potato growing areas are common throughout the United States. This is because of the compatibility of utilizing cattle to value-add rotation crops and by-products produced by the potato industry. Analysis of data from small (50 to 100 head) feedlot operations in Maine indicate that a well managed enterprise can be expected to return to labor and investment between $62.24 and $146.79 per head. The key components of a successful cattle feeding operation is facilities, cattle selection, health management, ration, and marketing.

Facilities: The University of Maine Cooperative Extension conducted a study to develop feedlot design recommendation which best suited Aroostook County. This report is available through your local Extension office. The recommendation is for a three-sided shed design with an outside lot. Due to weather considerations, the bunk should be located on the interior of the building, and 15 to 25 ft^2 of barn space per head is required depending on the size of the cattle. The exterior lot should provide 150 to 300 ft^2 per head if unpaved with 25 to 30 ft^2 of mounded area per head available to avoid mud. If the exterior lot is paved, 50 ft^2 per head should be provided. This system offers cost benefits over other designs while providing enough flexibility so that the facility can be utilized for other purposes.

Cattle Selection: Aroostook County has one of the highest commercial cow-calf populations in the northeast (estimated at 4,000 cows). The level of genetic potential amongst these cattle varies greatly and dealing with a reputable farmer or dealer is necessary. Cattle should be healthy, castrated and dehorned. When purchasing from a private individual, it is useful to check the sire that was utilized and the cow herd. Purchasing from farms that utilize the state's performance testing program is desirable. The cattle must be capable of gaining over 2.5 lbs. a day once started on a high energy ration. The Maine Feeder Cattle Sales are an excellent option for securing cattle in the fall. In 1992, over 1,500 head were marketed in the three days of sales. It is important to keep a record of how cattle perform from different sources so that they can be priced accordingly in the future.

Health Management: Death loss must be kept under 1.5%. The University of Maine Cooperative Extension and the Department of Animal, Veterinary and Aquatic Sciences has developed a feed lot health program that is effective. It is necessary that a lot have excellent cattle handling facilities (working chute, head gate, etc.) for any health program to be implemented. Numerous plans for cattle handling facilities are available through your local Extension office. The primary factors that are required to successfully starting cattle is a ration designed for stressed cattle, careful observation, and an aggressive treatment regime. The majority of death loss occurs either because treatment is not started early enough, ineffective drugs are utilized, or treatment is stopped too soon. At least three weeks should allotted when cattle are received, so if necessary, treatment can be done on a timely fashion.

Ration: Three goals must be met for a finishing program to be successful. The ration must be balanced to meet the nutrient requirements of the animal. Both feed companies and Extension staff can assist an enterprise to develop a diet. Second, the ration must be formulated for cost efficiency. This includes adequate energy levels for lowest cost of gain, and use of available technologies such as growth promotants. The strength of feeding cattle as part of a potato operation is that in a bad potato year, the cost of a ration is usually low due to the increased availability of cull potatoes. In a year when inventory of potato by-products exceeds the need for cattle feed, the potatoes can be ensiled and utilized as feed the subsequent year. The third factor that is necessary is that the ration must be delivered in a consistent manner to avoid digestive problems. Excellent feed bunk management is easily achieved and critical to success. When feed is not mixed and delivered consistently bloating, acidosis and poor performance will occur. Twenty percent of all cattle death loss results from digestive problems, most of which can be attributed to bunk management. Cooperative Extension has a eight lesson ITV Cattle Nutrition Shortcourse which can be obtained by contacting your local office.

Marketing: The primary commercial markets available to Maine feedlot producers are HUB Packing in New Brunswick, and Taylor Packing and Moyer Packing both of Pennsylvania. These operations each process between 500 and 1,000 head per day and are within one day's trucking. The Canadian grading system has recently changed but still favors lean cattle. The American system favors cattle which are highly finished. This market flexibility puts Maine in a favorable position to feed different biological types of cattle and cattle for varying lengths of time depending on market circumstances. The cattle industry is cyclic in nature, and following the markets and hedging greatly contribute to profitability.

Feeding cattle can be a method of rewarding management for rotation by providing a stable market for the crops produced. It also allows an operation to value-add by-products and return organic matter to the soil in the form of manure. The mission of managing a successful potato farm can certainly include feeding cattle to enhance profitability of the total enterprise. However, to achieve this objective, expertise must be acquired and applied in the critical areas of facilities, cattle selection, health management, ration formulation and delivery, and marketing. Without proper management and control over these areas a cattle feeding enterprise will not succeed regardless of profit potential.

REPORT

FOR

UNIVERSITY OF MAINE

BEEF FEEDLOT FACILITIES

FOR

FEEDING POTATO PROCESSING WASTES

BY

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Waste potato products and other under utilized agricultural commodities represent an inexpensive energy source for cattle production. Oat and hay production on rotated acres offer feed which is currently being under utilized. Oat grain is being exported from the Aroostook County at much below the national average price. Hay is also available at extremely competitive rates in the county. It would appear that cattle production in the area would be an excellent use of these rather inexpensive resources while providing a value added industry for the region. The location of Aroostook County with respect to the Canadian border appears to offer an excellent marketing opportunity for beef produced in the county. There is a good demand for a lean beef which meets Canadian meat grading standards. It appears that beef can be produced at a considerably lower cost in the U.S. as a result of lower priced feeder cattle and cheaper feed prices.

Increasing beef production in northern Maine can have the advantage of increasing business activity while providing a benefit to the established potato industry. However, it will require coordinated effort to promote both cattle feeding and cow-calf operations along with an infrastructure to provide basic supplies and support for a beef industry. Expertise in raising and feeding cattle must be developed through education and experience to develop efficient producers who can be competitive. Animal health and nutrition services must be available to producers especially during startup. Proper facilities must be provided for animal performance as well as efficient use of producer labor. Venture capital must be made available to implement a project of the scope and magnitude to benefit the region.

The major thrust of this report deals with recommendations for proper housing, handling and feeding facilities to help encourage this opportunity to start a potential new industry for the area.

Making recommendations on the optimum beef production system for Northern Maine is more difficult as a result of the lack of experience and information from other than a few local producers. Results of research from other parts of the country have been extrapolated to predict, as well as possible, the effects expected in Maine. Average weather conditions have been studied to estimate these effects on cattle production. Animal performance using waste potatoes, potato processing wastes, and other local feedstuffs is not well documented and is an unknown, especially when estimating the effect of shelter on animals being fed such rations, where most research on housing has been done with high energy rations with grains and supplements. Nevertheless, housing effects on beef performance have been assumed to be independent of ration type as long as the ration provides sufficient energy and nutrients for the animals.

REVIEW OF LITERATURE

During the early 1970's, the beef feeding industry underwent major consolidation and relocation as a result of economies of scale and as new technology was put into place. During this period, some research was done to evaluate different areas of the country for potential for beef feeding and the type of system best suited to the area. Butchbaker,et al.(1972) suggested housing and waste management alternatives based on temperature and moisture deficits for an area. They suggested that the country could be segmented into regions based on summer and winter temperatures as well as moisture deficits based annual rainfall and lake evaporation. Their regional map of the U.S. is shown in Figure 1. This would place Aroostook County in the cold, wet region where average January temperatures are lower than 20 degrees F and between 0 and 10 inches annual moisture surplus, represented as the difference between rainfall and lake evaporation. Under this criterion, Northern Maine would be placed in the same general region as Northern Iowa and Minnesota. This can be used to support the extrapolation of some Midwest data on beef performance to Maine.

Henderson and Geasler (1968) reviewed research up to the late 60's regarding the effect of confinement on the performance of feedlot cattle under Midwest conditions. They found that from a total of 68 feeding trials reviewed, average daily gain for a no housing group during winter conditions was consistently depressed from 2 to 22% (12% average), feed cost was consistently increased from 4 to 28% (14% average), and carcass grade was slightly depressed. For summer feeding trials, average daily gain for the no housing group was consistently depressed from 2 to 7% (5% average), feed cost was increased and average carcass grade not affected.

In Minnesota, Bates,et al.(1970) and Smith,et al.(1970) reported the influence of housing on performance of beef cattle housed in five different structures and found that warm housing produced the highest daily gain with the lowest amount of feed per unit gain. The major advantage of shelter occurred during the period from February to May in southwestern Minnesota.

Hoffman and Self (1970) found that shelter significantly increased rate of gain in both summer and winter. Feed efficiency was not significantly different between summer and winter trials. Floor surface did not affect rate of gain, feed intake or efficiency. In this study, cattle were allowed access to an outside lot and not totally confined indoors. Hoffman and Self(1974) reported later that total confinement over a 3 1/2 year period did not significantly increase rate of gain but produced a lower cost of gain when compared to open feedlots. However, cattle housed in sheltered open lots performed better than cattle in both open lots and total confinement. Average daily gains were nearly 10% greater and feed cost per pound of gain was reduced by 14 % with the use of shelter.

VISIT AND INTERVIEW

On June 28,1989, Dwaine Bundy and Stewart Melvin traveled to Aroostook County, Maine to evaluate the area for potential feedlot development. We visited the Ray Cory farm soon after our arrival where we observed one of the larger operations in the area. Cattle were being fed cull potatoes and potato processing wastes along with grain in both an open feedlot with no shelter other than woodland and in a solid floor total confinement barn. The cattle were being fed once a day in large capacity concrete feedbunks. Even though we did not see performance records, the operator was satisfied with the performance of the cattle except for cold winter periods in the outdoor facilities. His experience had indicated that confined cattle significantly outperformed during the winter feeding period.

Later that evening, we met with several local beef producers and potential producers at the Houlton Soil Conservation Service office. We heard the comments from each of the producers in attendance and discussed the alternatives for cattle feeding facilities in northern Maine. Those producers who had confinement facilities described their operations and an evaluation of their own system. One of the major discussion items was the need for inside or covered feeding in the area. It was generally agreed that under cover feeding would be quite beneficial to minimize bunk management problems especially during winter storm periods. We suggested that a shelter with an inside feeding alleyway, solid floor and an outside lot area with mounds would be expected to provide optimum animal performance over all weather conditions for the local climate. Local Soil Conservation Service personnel and Neal Halee, Extension Agricultural Engineer were valuable resource people to describe local soil, weather, and building requirements for the area.

The following morning was spent evaluating potential building sites on the Otis Smith farm and gathering building material availability and costs in the Houlton area. Information on native lumber, poles, and sawed posts was obtained for structural engineering and cost estimation for proposed feedlot facilities. At lunch we met with members of the financial community and with a local builder to obtain information on construction techniques, especially where ledge rock was known to be near the surface. More information was obtained that afternoon on the structural lumber availability. We attended a reception that evening to meet with many dignitaries representing the Commissioner of Agriculture's office, University of Maine, the financial community, and venture capitalists in the area. Dr. Robert Hough presented the objectives of the project and outlined the economic impact of developing the beef industry in Aroostook County.

During the next morning, another site for a confinement system was evaluated for Ken Ratzlaff who is planning a confinement operation for a specialty beef market. Recommendations for location and layout of the system were given at the proposed site Northeast of Presque Isle.

Even though we did not have the opportunity to stay in the area longer, the visit allowed us to evaluate the area resources, needs and potential problems to be addressed. Our evaluation of the trip was that there appears to be a good potential to develop a beef feeding industry to meet a local and selected market in the area including the Canadian side of the border, but many obstacles need to be addressed especially from an engineering perspective. Our perception of building type to recommend did not change as a result of the visit but the ways to construct the building, lots and holding areas were. One other issue that was assumed to be minor by those we visited with was the environmental impact of beef feedlot facilities on air and water resources of the area. Little restrictions are required for small feedlot operations less that 1000 animal unit capacity. However, the potential to have environmental problems as a result of poor management of confinement beef feeding facilities is present, especially in an environmentally sensitive state such as Maine.

DESIGN CRITERIA

Design of beef confinement systems in Aroostook County, Maine is difficult since there is little background information or experience from which to draw for design of facilitites in the area. Because of the similarity to northern regions of the Midwest, Midwest Plan Service criteria have been used as a basis for many of our recommendations. Aroostook County, Maine has a humid, cool, continental climate, similar to states like North Dakota and Minnesota. Winters are long, cold, and windy. Temperatures fall below zero between November and April. In Presque Isle, temperatures can be expected to be to drop below 0 F., 43 days of the year. Because of this adverse climate, we feel that shelter is necessary for any year around beef feeding operation. Ground snow loads as high as 100 psf can be experienced as a result of an average annual snowfall of nearly 100 inches. At Houlton, the maximum net accumulation averages 27 inches, with a maximum of 45 inches.

Since we have been asked to provide recommendations for beef feeding facilities in NE Maine, we have had to make some basic assumptions regarding the level of management to be provided and the type of operation which is appropriate for the area. From our discussions with producers in the summer and followup discussions with University of Maine personnel, most producers will enter the beef feeding business as a supplemental enterprise to potato and small grain production. We were asked to keep investments low to assist non- experienced cattle producers into the business, while providing for facilities that would adequately protect the animals throughout the year.

ECONOMICS

After visiting the area and studying the weather conditions, our conclusion was to provide a combination shelter-open lot system with enough space to house the animals under roof during inclement weather, while allowing the freedom of the outdoor lot during periods of better weather. Such systems have been shown to be optimum for Midwest conditions in terms of investment requirements and animal performance(Iowa State University ,1986). In the Iowa State University study, it was shown that the combination of shelter with a small outside lot was the most profitable system for feedlots of 500 head capacity. Based on this comprehensive study,we recommend that an open front, paved shelter with a mounded outside lot be used to meet the objectives. We propose to recommend an open lot system with shelter that has been adapted to meet NE Maine conditions.

RECOMMENDATIONS AND RATIONALE

FEEDLOT TYPE

A partial confinement system consisting of an offset gable roof building and a mounded earthen outside lot is recommended as the system to best incorporate the objectives of economic design and adequate shelter for good animal performance. The system is shown in plan view in Plan Sheet 2. Building elevations are presented in Plan Sheets 3 and 4. The building is designed to provide 15 square feet per head and an open lot area of 100 square feet per head at maximum capacity. The capacity for the unit shown is 480, or 80 animals in each of six pens. An alternate plan would be to have four pens of 120 animals with a single mound within each lot area. The north side of the proposed cattle shelter is used as a feeding alley and for animal handling. Except for the feeding apron,the inside of the building is recommended to be surfaced with asphalt to reduce expenses. The feeding apron, outside cleaning apron and watering pad are to be constructed of concrete to withstand heavy traffic and cleaning equipment. The building is naturally ventilated through an open ridge vent at the peak of the roof. Windbreak fences are recommended to minimize winter wind chill and snow drifing problems. This design provides a barn space considered the minimum possible to house cattle during inclement conditions. The allocated area of 15 sq ft per animal is lower than recommended by Midwest Plan Service for animals 800 pounds or larger. Feedlot capacity may need to be reduced if large animals will be fed during winter periods.

STRUCTURAL CONSIDERATIONS

Materials:
The structural design is based upon native lumber to Maine. The wood specified includes:

Roof Purlins	Hemlock #2	2 x 4 (on edge)
Wall girts	Hemlock #1	2 x 6 (sidewalls)
Wall girts	Hemlock #1	2 x 4 (endwalls)
Bracing	Hemlock #2	2 x 6 (post to truss)
Posts	Hemlock #1	6 x 8 (long posts)
		6 x 6 (short posts)

Snow, Wind, and dead loads:
The loadings used for this design includes 45 psf snow load, wind pressures based upon 80 mph wind, and a dead load of 2.5 psf.
Footing design:
The footing design is based upon allowing 4 ft embedment depth which is unlikely to be achieved in this location. An alternative to this is to place the column upon the top of the bedrock with 4-#4 rebars 4 ft in length drilled into the bedrock approximately 18 to 24 inches. Then pour 2 ft diameter of concrete around the post with 2-#4 rebars extended horizontally through the post into the concrete. The horizontal rods should be 20 inches long. Note that the bedrock should go below frost line in a solid piece to prevent frost heaving.

FEED STORAGE

Feed storage requirements will vary with the proposed feed source. However, recommended rations will be used to estimate feed storage requirements. Dr. Hough has suggested that potato processing waste materials be used to ensile with dry hay and grain. His estimates for a calf feeding program would require approximately 354 tons of 35% DM potato silage to feed out 100 of calves, assuming a 600 lb weight gain and a 2.5 ADG. In addition, some 82 tons of small grains would be required per 100 head. Supplement requirements would be aproximately three tons per 100 head. Since potato processing wastes will be available during a 7-8 month period, a silage storage facility to store 6 to 8 months of feed requirement should be available.. An eight month supply would provide enough excess storage to completely feed one set of calves through the finishing facility. This would allow sufficient storage during the period when processing wastes are not available. For the specific case of a 450-500 head capacity unit, some 60 animals per month could be finished. A seven month storage period would require 1450 tons capacity. Since silage must be formulated during the potato processing season, it is suggested that two compartments be designed in a horizontal silo to allow for feeding from one compartment while formulating feed in the other. For a 1450 ton total storage system, one alternative would be as shown in Plan Sheet 2 with a 50 ft. by 150 ft bunker silo 10 ft. deep split in the middle to obtain two separate compartments. Another alternative would be to use two side by side sections 80 feet long and 40 feet wide by 12 feet deep. This would minimize floor surface for the volume stored. Other alternatives could be used, but the cross sectional area of the exposed surface on the feeding face of the horizontal silo should not execeed 2 square ft per animal. This will minimize spoilage loss by removing a minimum of 4 inches per day from the working face of the silo. Another alternative storage technique would be a tower silo. An equivalent tower silo would be a 30 ft diameter, 80 ft high. Bottom unloading would be necessary if only one silo would be used for multiple fillings. Otherwise two smaller structures would be necessary.

Dry grain storage for a 480 capacity unit will depend on the grain purchasing arrangement by the feedlot operator. If little grain is stored in the area, it may require that the feedlot operator purchase most of the year's grain during harvest season to obtain a supply at a low price. Some alternative storage facilities such as potato storages may be available for grain storage at least for summer periods before potato harvest. If all grain must be stored at a site where 480 cattle are being fed year around, some 590 tons storage would be required. For oats, this represents 36,900 bushels. For barley, 24,600 bushels would be required for a system that finished 720 animals per year. A minimum of one month's storage should be placed on the feedlot site unless grain storage is close to the feedlot area.

Most supplement storage requirements could be store in relatively small hopper bottom bins. The supplement requirement is estimated to be 1.8 tons per month. For a four month storage, a round 6 ft diameter hopper bottom bin with 24 inch slide valve clearance, and 18 1/2 ft overall height would be recommended for the 480 capacity unit.

ANIMAL HANDLING FACILITIES

The cattle handling facility is designed to permit cattle to be moved out of any pen, down the feed alley to the working area to be processed and back to the pen.

A curved chute is preferred over a straight run as cattle will move more easily when their forward vision is restricted.

Provisions are included for two hospital pens. The sides of the hospital pens facing the working alley should be solid to avoid nose to nose contact with animals in these pens.

After processing through the chute, animals can be held temporarily in one of the small holding pens along side the working chute, moved to a hospital pen or returned to their original pens through the feed alley.

The working chute should have a blocking gate to hold cattle. A cutting gate is helpful so animals not needing treatment do not have to go through the squeeze.

The roof of the building can be extended so the entire working facility is covered for protection from the weather.

MANURE HANDLING AND DISPOSAL

Manure will be handled as a solid from the recommended unit. Scraping manure from the building and lot will be necessary for good management. The building should be scraped at weekly intervals when possible. During the winter, it is anticipated that manure will be frozen inside the building for short periods during extremely cold conditions. It will be necessary to remove manure when the manure pack thaws temporarily during warm weather periods. Some bedding may be necessary when manure deposits cannot be cleaned and animals become wet during the thawing process. Temporary storage of winter manure accumulations may be necessary if snow cover makes field disposal impossible. The lot should be scraped at least monthly during the summer. In the spring, manure should be removed from the lot area as quickly ofter thawing as possible to minimize runoff losses and to maintain stable lot conditions. During winter, snow should be removed from mounds to maintain comfortable resting positions for the cattle. Manure scraped from the building can be removed from the lot area or temporarily stored on mounds where it would be allowed to refreeze. This manure should be removed as soon as possible in the spring to prevent runoff and to maintain as dry a lot condition as possible. Each lot space, if occupied continuously, will produce approximately one ton of dry solids per year per lot space. If we assume that manure is handled at approximately 50% dry matter on the average throughout the year, Each lot space will produce approximately 2 tons of wet manure per lot space. This represents approximately 135 cubic feet of wet solid waste generated per day that will require eventual handling and proper disposal.

Nitrogen management is necessary to prevent surface and groundwater contamination. Each lot space will generate approximately 100 pound of nitrogen in excreted waste annually. For our recommended unit of 480 head capacity, the total nitrogen excreted by the cattle is estimated to be approximately 48000 pounds annually. It is estimated that at least 50% of the total will be volitilized into the atmosphere before the manure can be hauled to a field site. Unless rapid incorporation of manure after spreading is performed, some remaining nitrogen will volatilize from the disposal site. It is estimated that only about 40% of the total nitrogen excreted will be utilized on cropland from an open lot system. Higher nitrogen retention efficiencies can be obtained with frequent cleanings and rapid incorporation of manure into soil after spreading. Heavy application of animal manure is not recommended to prevent potential nitrate leaching into shallow groundwater. If nitrogen applications are limited to a total of 150 pounds per acre for cropland, a minimum of 128 acres would be required for adequate disposal. Local soil scientists and crop productions specialists in the area should be consulted to determine optimum nitrogen application rates for various crops in the region. Manure from open lot beef facilities will be an excellent source of both phosphorus and potassium. In fact, the soid manure applied to cropland from this type of unit will be relatively high in both nutrients when compared to nitrogen. Significant amounts of nitrogen have been lost to the atmosphere prior to incorporation into cropland whereas phosphorus and potassium are relatively conservative elements in the system. Small amounts of potassium may be leached away in lot runoff but most of the P and K nutrients will be reclaimed if manure solids are well managed. Applications of manure on cropland may well be determined by maximum applicaions of phosphorus rather than nitrogen. If phosphorous soil tests rise to very high readings where manure is applied, applications should be lowered or other areas should be selected as a disposal site.

ENVIRONMENTAL CONSIDERATIONS

Before any beef feeding facility is located, factors must be considered to minimize the environmental impact in the area. One of the first considerations to minimize odor impacts would be proximity to neighboring residences, public use areas, or roadways. Odor is best controlled by using good waste management techniques and with proper siting of the feedlot area. Odors will be most intense during warm wet periods. Try to locate feedlots at least 1260 feet from the nearest residence not owned by the feedlot owner. Select sites that are downwind from the prevaling summer wind direction. Sites that are not visible by neighbors are also recommended to minimize visual impact. However, well kept confinement systems can be a positive addition to the visual landscape in many rural areas.

Water pollution hazards should also be addressed before siting an animal production facility. Poor location with respect to streams, other surface water sources and shallow groundater aquifers can increase the chance for environmental degradation. A open animal feedlot in Northern Maine can be expected to generate 14-18 inches of surface runoff annually, based on midwestern experience. Rainfall intensities are significantly lower in Maine as compared to Iowa or Illinois , but evaporation is lower and snowmelt runoff higher. Earthen lots in the midwest are estimated to generate 12-14 inches of runoff annually. If feedlot are placed close to a stream, feedlot runoff can have a neqative impact on the receiving stream as a result of high BOD and ammonia loadings. Feedlot runoff can contain as much as 1000 mg/l of BOD. If natural topograpic conditions do not filter and absorb much of this liquid before it reaches the receiving stream,.stream water quality can be degraded. One of the criteria recently used in Iowa regarding feedlot runoff potential has been to expand small feedlots(less than 1000 animal unit cap) with at least 2 ft per head capacity from a stream from state registration requirements. If feedlots were closer to a stream than this criteria, feedlot runoff control systems were required for operation. For small feedlots, complete retention and disposal of feedlot runoff has not been required by most states. However, national EPA regulations require any feedlot of over 1000 animal units to have a discharge permit if any water is discharged from a storm duration of 24 hours and a 25 year return interval. This would be approximately 4 inches in a 24 hour period in Northern Maine. Feedlots should be located well upslope on sites in Aroostook County to allow for separations from watercourses in valleys below. This will allow runoff to to be renovated by grass filters as it moves downslope before it reachs the stream. If the natural topography is not sufficient to provide adequate treatment, grass filtration systems or runoff holding basins can be constructed in the area between the feedlot and the stream. Such systems can be designed as illustrated in MWPS-18, Livestock Waste Facilities Handbook. We have shown on our recommended plan that a minimum treatment system be a settling channel at the bottom of the feedlot. These channels are effective in removing settleable solids prior to discharging feedlot runoff. Individual feedlot runoff control treatment systems will vary with site.

There has been some concern expressed regarding locating an open feedlot on sideslope areas where ledge rock is near the surface. The concern is over the potential groundwater pollution hazard resulting from a manure covered surface near the ledge fromation. Even though data does not exist for Maine, previous experience with feedlot surfaces have shown that they become almost impervious to percolation even with relatively permeable soils at the surface as a result of the compacted anaerobic zone that forms 4-8 inches below a feedlot surface. Cattle hooves in conjunction with manure form a compacted zone that becomes quickly sealed with organic solids. If a minimum cover of 6-10 inches of soil is placed over ledge rock, little infiltration would be expected. In addition, in many slopes the ledge may represent a discharging system rather than and infiltration system which would lessen the potential even further. Feedlots should be sited to prevent runoff discharging from the feedlot surface to enter a shallow ledge rock area for infiltration. The ledge may represent an infiltration zone below a feedlot where the surface is not compacted. Midwestern studies have shown that nitrate accumulations are high below feedlot areas where rapid infiltration takes place, while little nitrate is found below an active feedlot surface.

If regulatory restrictions prevent location of feedlots in ledge areas, paving outside lot areas is an alternative. Paved lot will require much less area(approximately 50 sq.ft. per animal) than an earthen lot. Paving will decrease the outside lot area required to 1/5 to 1/6 that required with earth lots. More runoff would be expected per unit area, but the smaller lot area will result in less total runoff. Paved cleaning aprons and settling basins may be required in sensitive areas to minimize groundwater infiltration impacts. Manure will be handled as a wetter material, so wet manure solids volume will be higher than with earthen lots. The economic implications of choosing the paved lot over the earthen lot will depend on the cost of paving. The 1986 Iowa State University report indicated that the capital cost for a paved lot to be increased by approximatly $15 per animal capacity when compared to an earthen lot.

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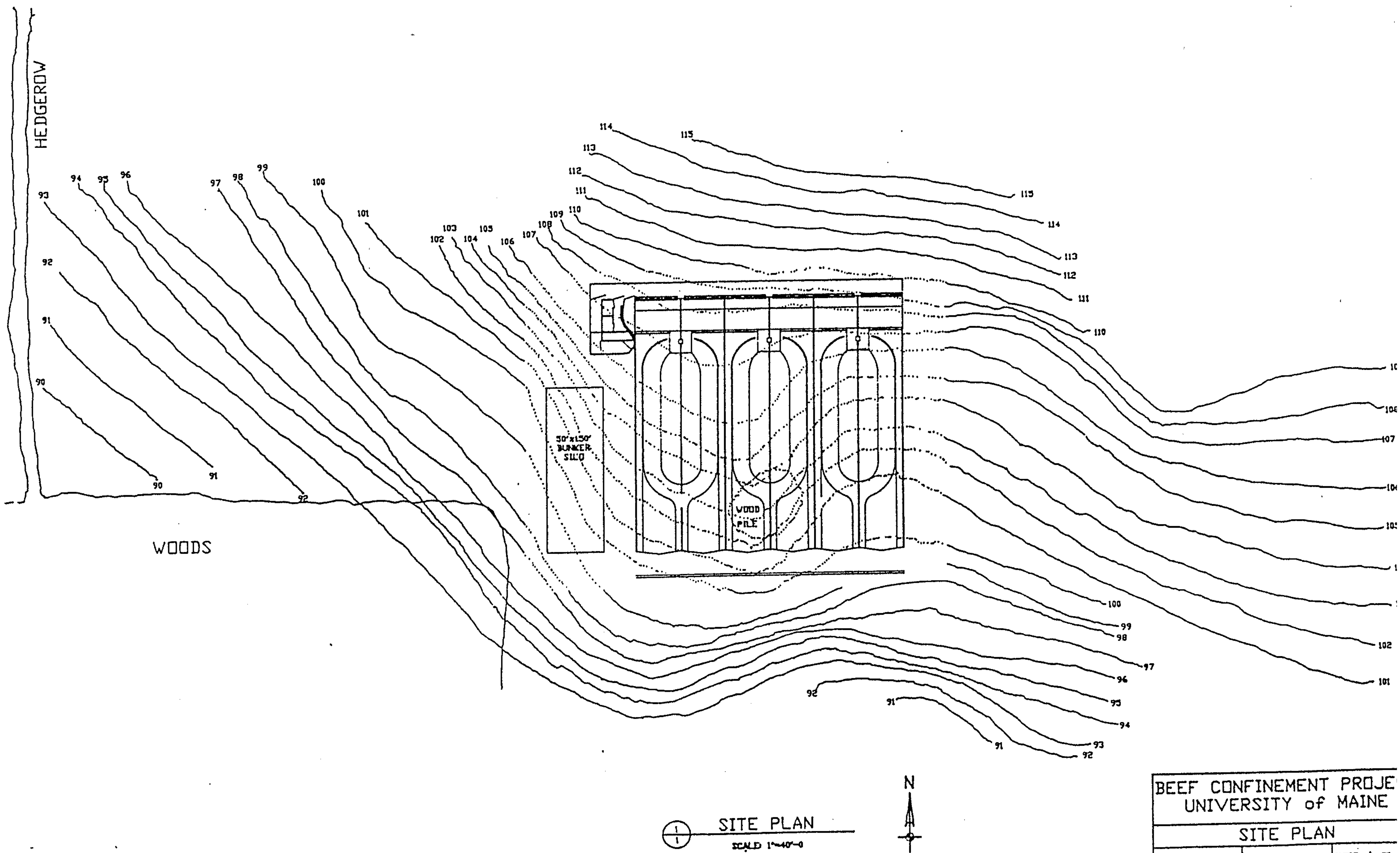
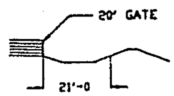
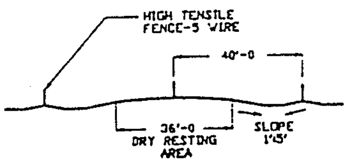


SITE PLAN
SCALE 1"=40'-0

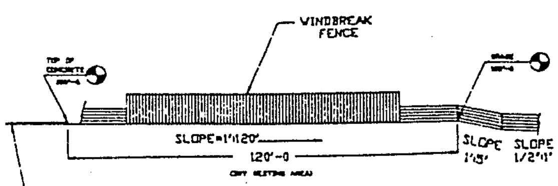
BEEF CONFINEMENT PROJE		
UNIVERSITY of MAINE		
SITE PLAN		
DRAWN BY: N H	DATE: 3-15-90	SHEET 1 OF
APPROVED	REV.	FILE NO.



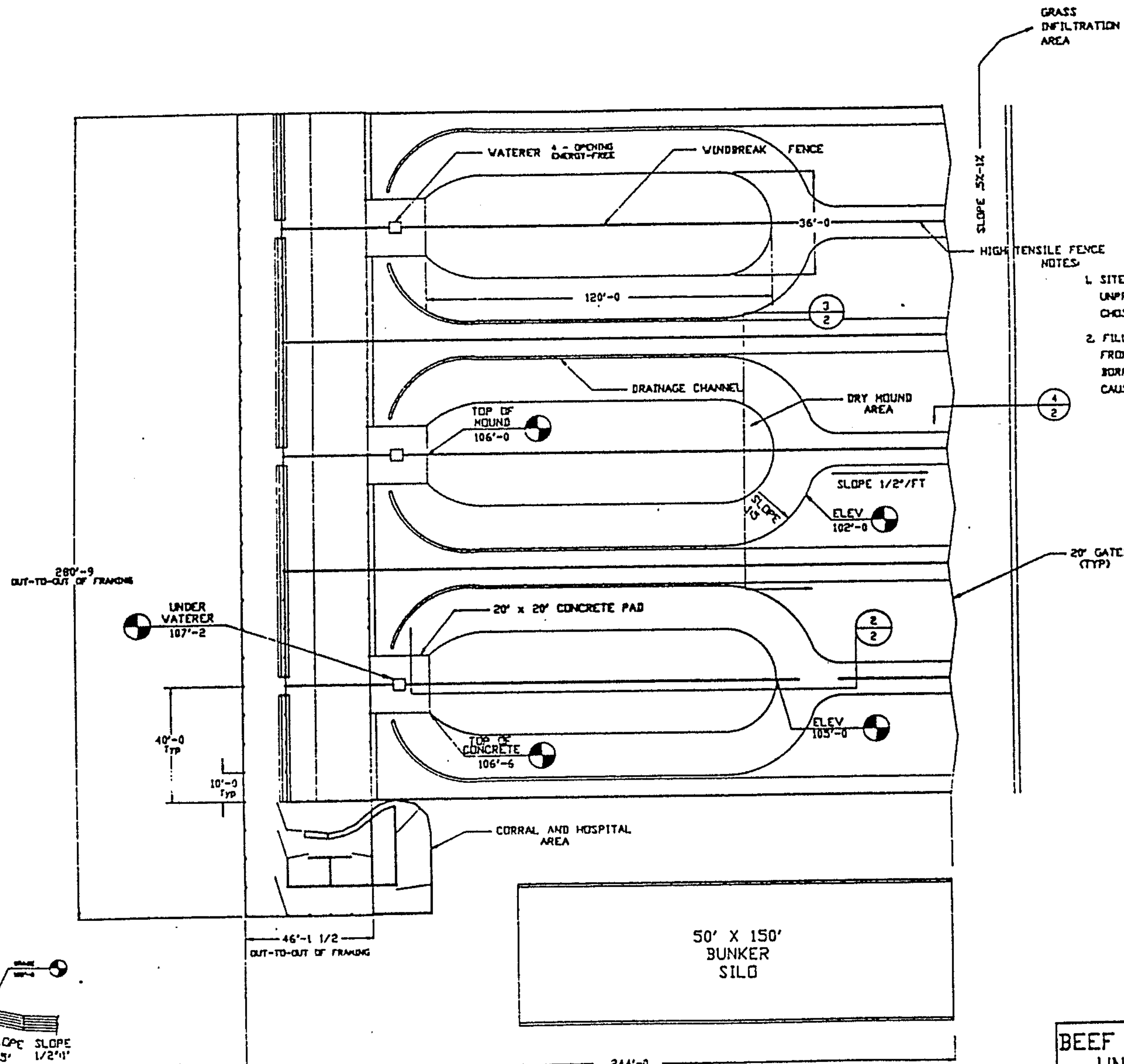
4/2 COLLECTION DITCH
SCALE: 1"=20'-0



3/2 MOUND CROSS SEC
SCALE: 1"=20'-0



2/2 MOUND SEC
SCALE: 1"=20'-0



NOTES:

1. SITEWORK MAY VARY SUBSTANTIALLY DUE TO UNPREDICTABLE CIRCUMSTANCES AT THE CHOSEN SITE.
2. FILL DIRT FOR MOUNDS MUST BE OBTAINED FROM PRESENT SITE &/OR ADJACENT AREAS. BORROW DIRT IN A MANNER AS NOT TO CAUSE EROSION.

N

1/2 PLAN
SCALE: 1"=20'-0

BEEF CONFINEMENT PROJECT UNIVERSITY of MAINE		
PLAN		
DRAWN BY: M H	DATD 3-15-90	SHEET 2 OF 3
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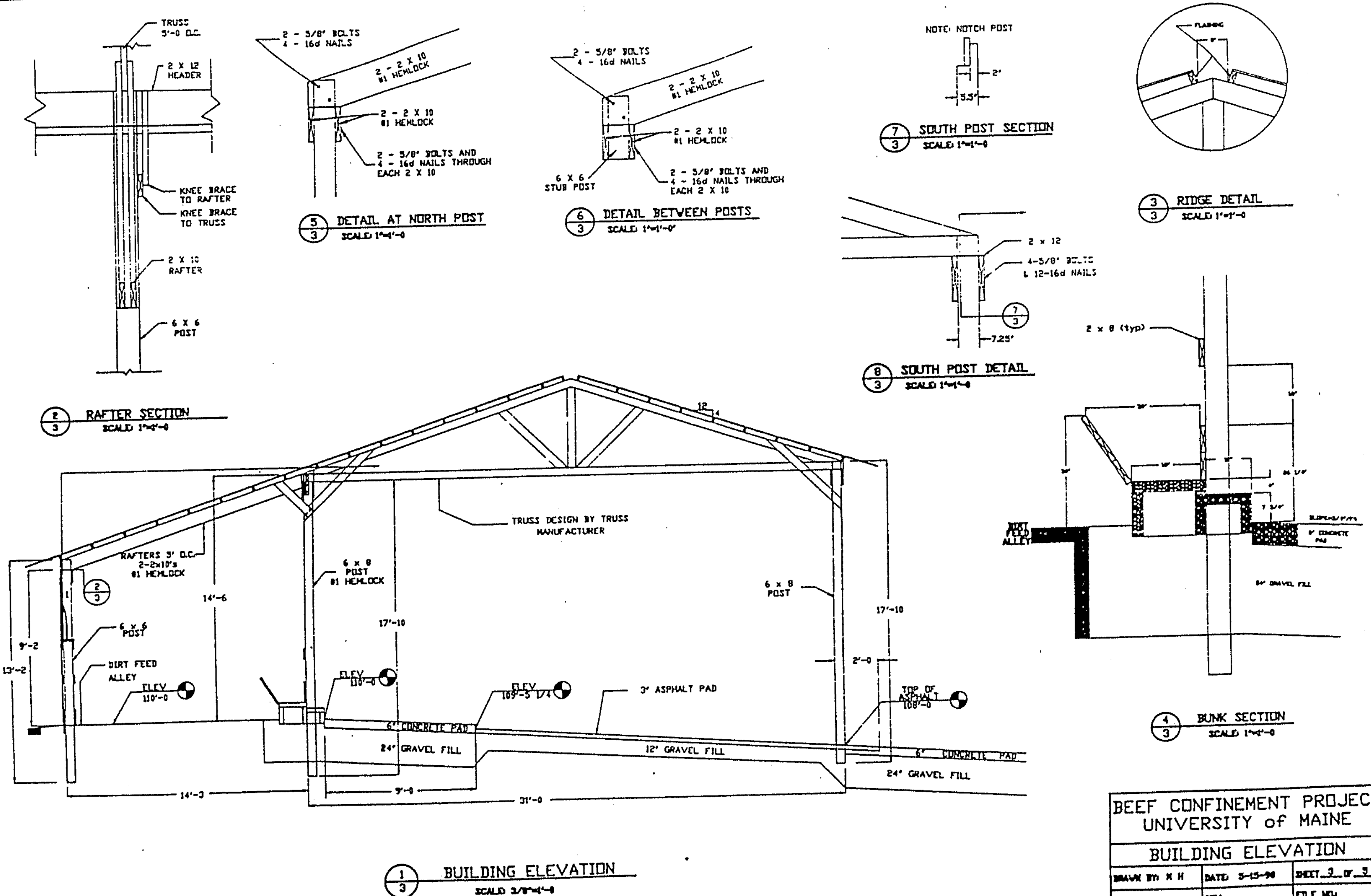
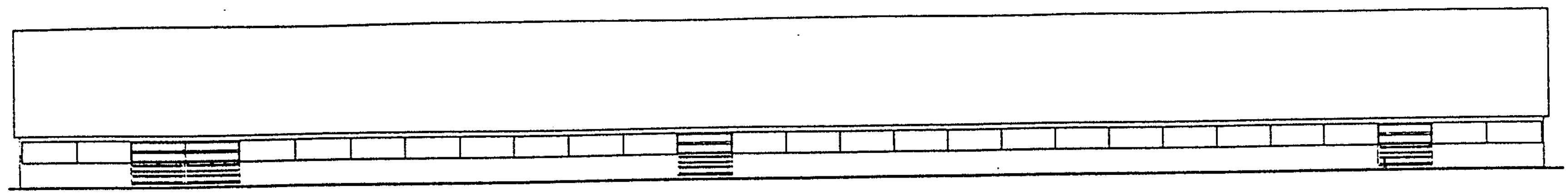
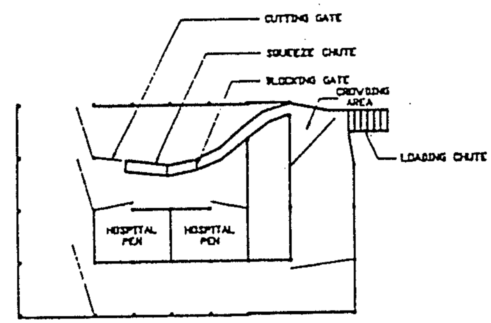


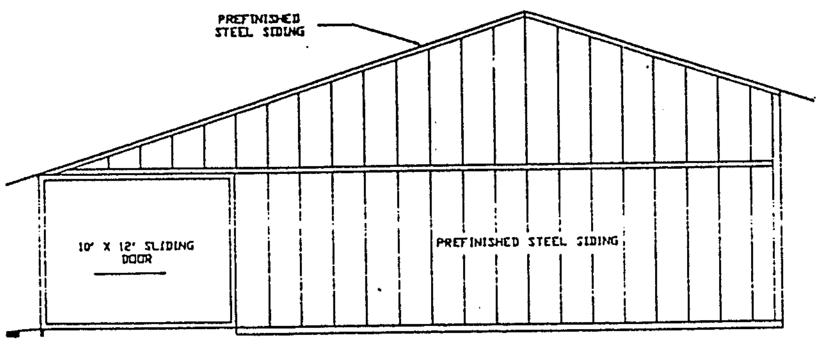
BEEF CONFINEMENT PROJECT UNIVERSITY of MAINE		
BUILDING ELEVATION		
DRAWN BY: K H	DATE: 5-15-96	SHEET 3 OF 3
APPROVED	REV	FILE NO



NORTH ELEVATION
SCALE 3/32"=1'-0"

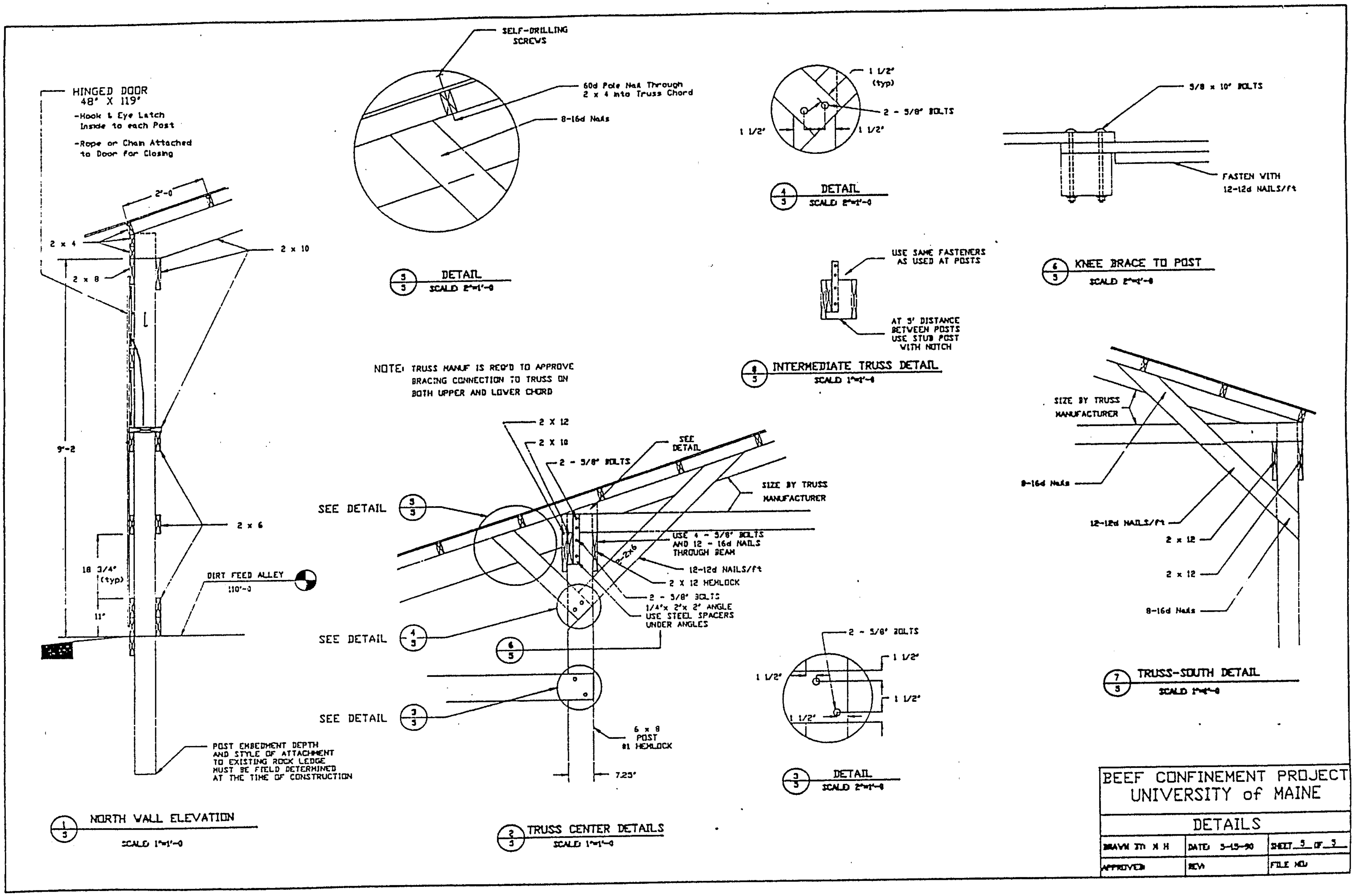


CORRAL AND HOSPITAL AREA
SCALE 1"=1'-0"



WEST ELEVATION
SCALE 1/4"=1'-0

BEEF CONFINEMENT PROJE UNIVERSITY of MAINE		
ELEVATIONS & CORRAL AREA		
DRAWN BY M H	DATD 5-15-98	SHEET 4 OF
APPROVED	REV	FILE NO



HINGED DOOR
48" X 119"
-Hook & Eye Latch Inside to each Post
-Rope or Chain Attached to Door for Closing
2'-0
2 x 4
2 x 8
2 x 10
9'-2
2 x 6
18 3/4" (typ)
11"
DIRT FEED ALLEY
110'-0
POST EMBEDMENT DEPTH AND STYLE OF ATTACHMENT TO EXISTING ROCK LEDGE MUST BE FIELD DETERMINED AT THE TIME OF CONSTRUCTION
1/3 NORTH WALL ELEVATION
SCALE 1"=1'-0
SELF-DRILLING SCREWS
60d Pole Nail Through 2 x 4 into Truss Chord
8-16d Nails
5/5 DETAIL
SCALE 2"=1'-0
NOTE: TRUSS MANUF IS REQ'D TO APPROVE BRACING CONNECTION TO TRUSS ON BOTH UPPER AND LOWER CHORD
2 X 12
2 X 10
2 - 5/8" BOLTS
SEE DETAIL
SIZE BY TRUSS MANUFACTURER
USE 4 - 5/8" BOLTS AND 12 - 16d NAILS THROUGH BEAM
12-12d NAILS/ft
2 X 12 HEMLOCK
2 - 5/8" BOLTS
1/4"x 2"x 2" ANGLE
USE STEEL SPACERS UNDER ANGLES
2-2x6
SEE DETAIL 5/5
SEE DETAIL 4/5
6/5
SEE DETAIL 3/5
6 x 8 POST
#1 HEMLOCK
7.25"
2/3 TRUSS CENTER DETAILS
SCALE 1"=1'-0
1 1/2" (typ)
2 - 5/8" BOLTS
1 1/2"
1 1/2"
4/5 DETAIL
SCALE 2"=1'-0
USE SAME FASTENERS AS USED AT POSTS
AT 5' DISTANCE BETWEEN POSTS USE STUB POST WITH NOTCH
8/5 INTERMEDIATE TRUSS DETAIL
SCALE 1"=1'-0
2 - 5/8" BOLTS
1 1/2"
1 1/2"
1 1/2"
1 1/2"
3/5 DETAIL
SCALE 2"=1'-0
5/8 x 10" BOLTS
FASTEN WITH 12-12d NAILS/ft
6/5 KNEE BRACE TO POST
SCALE 2"=1'-0
SIZE BY TRUSS MANUFACTURER
8-16d Nails
12-12d NAILS/ft
2 x 12
2 x 12
8-16d Nails
7/5 TRUSS-SOUTH DETAIL
SCALE 1"=1'-0
BEEF CONFINEMENT PROJECT
UNIVERSITY of MAINE
DETAILS
DRAWN BY: K H
DATE: 5-15-90
SHEET 5 OF 5
APPROVED
REV:
FILE NO:

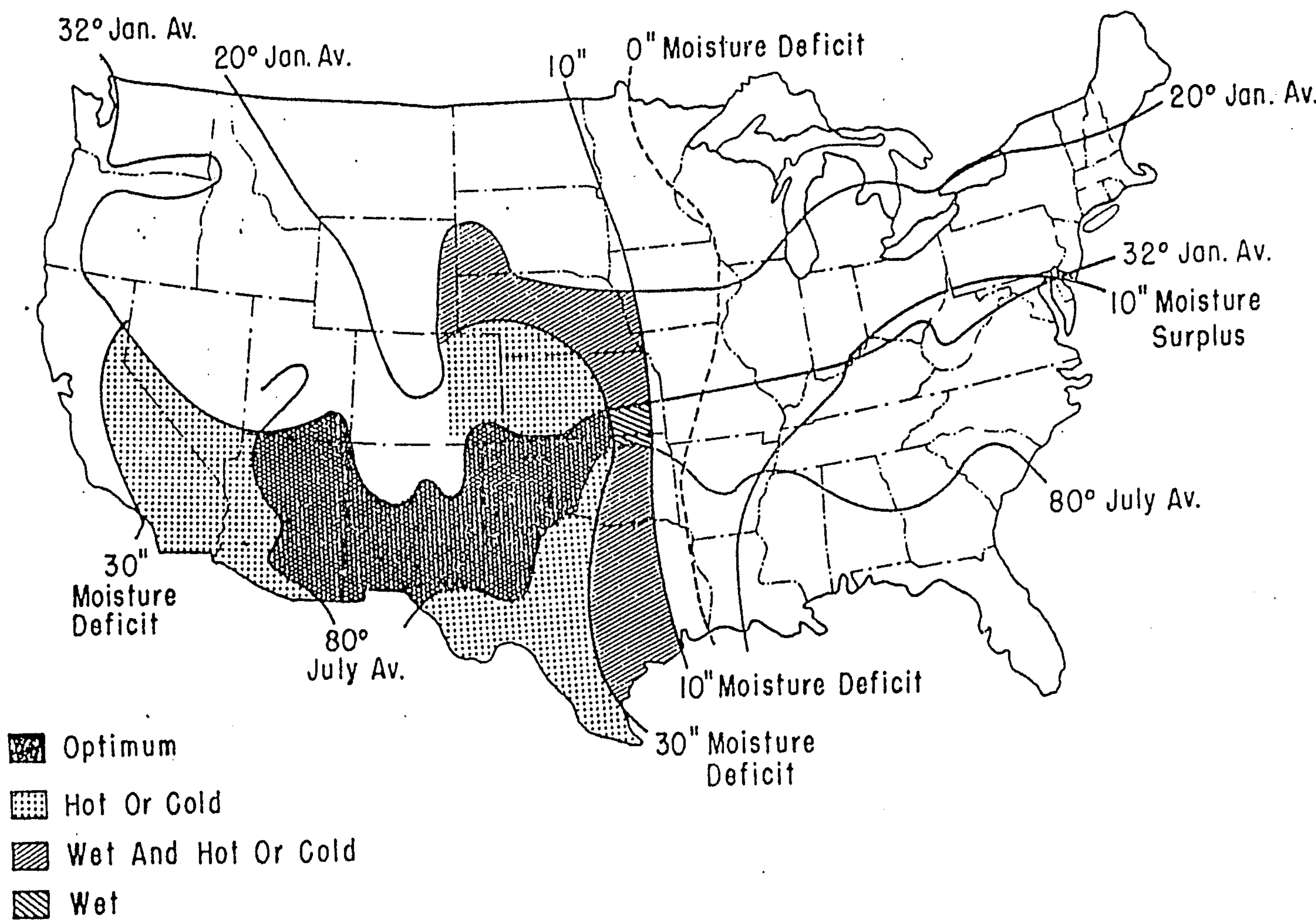


Figure 1. Beef cattle feeding areas based upon climate