A STUDY OF MECHANICAL GRAZING OF IRRIGATED PASTURE IN THE SOUTH SASKATCHEWAN RIVER DAM AREA*

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INTRODUCTION

Mechanical grazing is a process by which the feed is cut in the field, transported to the feedlot, and fed to the animals in the green state. This method is practiced on an intensive scale in Great Britain, mostly with dairy herds (2). In the United States, mechanical grazing has come into prominence in the years 1940-1960, due to more intensive land use in many States that have high rainfall or irrigated areas. United States reports indicate the feeding of corn as a concentrate in mechanical grazing (5). The Animal Husbandry Department of Iowa State University found that mechanical grazing resulted in more rapid beef gain with a lower cost per pound of gain than natural grazing. One of the more promisiing methods was the feeding of green feed with limited grain and no protein supplement. This conclusion was based on cost of gains, early marketing date with good slaughter finish, and the most suitable usage of the forage crop (7). The University of California tested alfalfa silage of various mixtures and additives. Sudan Hay, under free choice, caused little change in daily gain but a slight decrease in the production of beef. Barley increased gains but did not increase beef production per acre. Molasses not only decreased gains but lowered substantially the amount of beef produced (4).

Kamloops workers reported reduced pasture productivity under mechanical grazing. Costs were higher due to increased capital expenditures for the harvesting machine and greater labour involved in feeding the forage (6). Lethbridge tests showed mechanical grazing did not appreciably increase beef production per acre. Their results indicated that, although forage production was lower from the mechanically harvested fields than from the rotationally grazed fields, beef production per acre was greater. This may indicate that feed requirements for gain are lower in a feedlot where animals are confined than when they are grazing on pasture (1). Several years of mechanical grazing at Hays, Alberta, indicated that even in a year of low productivity of pasture and high labour costs, a net profit was still realized (3).

With the development of the South Saskatchewan River the Prairie Farm Rehabilitation Act wished to acquire information on mechanical grazing as a possible farm practise in the proposed area of irrigation development. The study was conducted to determine the economic and practical feasibility of mechanical grazing of irrigated pasture.

EXPERIMENTAL PROCEDURE

The Prairie Farm Rehabilitation Act (P.F.R.A.), Predevelopment (Irrigation) Farm was chosen as the site for the tests. One of the regular hay fields in the farm rotation was utilized for the mechanical grazing trials with no control group being used.

The first phase of the test was to determine pasture productivity under mechanical grazing conditions. Field tests were conducted every two weeks to determine the volume and quality of foliage produced. Final production values were later related to livestock gains. Dry matter percentages were calculated from replicated yield sampling of the growing foliage. Botanical analysis, percentage alfalfa, leafstem ratio, and protein determinations were conducted on the samples to provide additional data with respect to the type of feed that the steers received during each two week period. Weather factors affecting forage productivity, air temperature, rainfall, and relative humidity were recorded. Records were also kept on the irrigation and fertilizer applications.

A flail type forage harvester with shredding outlet, loading hood, and stationary deflector was used in the test. The forage harvester was driven by a 3-4 plow tractor with live pto. The cutting drum operated at the necessary 1600-1700 rpm to ensure adequate delivery in the feeding box. The mechanical wagon was of the self unloading type (side or rear) with the unloading mechanism operated by the tractor pto. The mechanical wagon was of a regular commercial type with side extensions and a screen top and back to trap the forage as it was blown from the forage harvester.

The second phase of the study was to evaluate the output value of pasture in terms of beef conversion based on mechanical harvesting. Fifty-four yearling steers, averaging 581 pounds, were randomly divided into two groups, one of 22 and 32 respectively. The group of 22 were injected with Synovex-S (growth hormone). The steers were kept in the feedlot and fed, twice daily, only the green chopped grass legume mixture from the pasture. Total field area measurements were used to determine the carrying capacity of the irrigated pasture. All forage from the field was weighed and recorded prior to feeding the animals. The livestock were individually weighed at regular two-week intervals. The feedlot was equipped with an automatic watering device, free choice mineral mixture, salt and necessary beding straws. A detailed account was kept of feeding problems with emphasis on the incidence of bloat. Detection, treatment, and post-treatment and after affects of bloat were recorded to provide evidence of the palatability and occurrence of waste of green feed.

Thirdly, a detailed account of feed, labour and capital costs were recorded to determine the economic feasibility of mechanical grazing. The current problems of equipment used, irrigation costs and feeding labour were treated in detail. A time and motion study on the feeding enterprise was included. Actual costs were estimated according to the type of power and equipment units and labour requirements for the various operations.

RESULTS

Pasture Productivity

The alfalfa percentage of the brome-alfalfa forage was 35-58% at the first cut but succeeding second and third cuts showed a substantial increase in alfalfa percentage. From a pasture standpoint this factor is unsatisfactory because of the high bloat danger.

The second and third harvests consisted of a greater number of shorter and less mature brome plants. The botanical analysis showed the brome plants quite high in number, yet a brome plant of 24 inches had very little total feed value compared to the alfalfa plants of equal height. The height of the forage at the beginning of cutting was approximately 16.5 in-

ches and at the end of the grazing period (89 days) measured 8.3 inches. This gave a loss of 8.2 inches in forage stand.

Leaf-stem ratios of brome and alfalfa, percentage composition and protein analysis were taken at the same time as the height and botanical analysis tests were being conducted, with results calculated on a dry matter basis. Illustration is shown in figure 1.

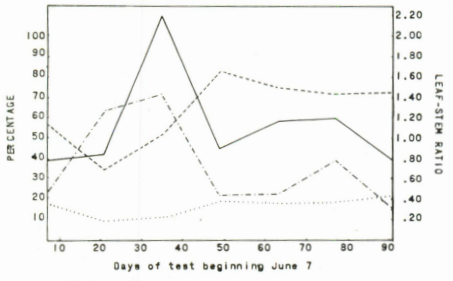

Figure 1. Alfalfa percentage of mixture, brome leaf-stem ratio, alfalfa leaf-stem ratio, and percentage protein during mechanical grazing period June 7 to September 1, 1962. P.F.R.A. Predevelopment Farm, Outlook.

Coefficient of Correlation Determination (r) value of 0.83 indicates the variation of protein is associated with the variation of alfalfa percentage ($r^2 = .69$). As the stem-leaf ratio of brome rose the percentage of protein fell ($r = -.72$). Fifty-one percent of the variations in protein are associated with variations in the stem-leaf ratio of brome. No significant difference was found in the percentage of alfalfa in the mixture on the seven dates of testing over the grazing period. Although a wide variation in means did occur not a large enough number of samples could be taken to get a significant test of difference. Visual inspection showed a great variation in the percentage alfalfa in the mixture over the summer period. No significant difference was found in the percentage alfalfa of the mixture between the dates of testing and locations of testing. Again the limited number of samples prevented establishment of a statistical basis for what was observed visually.

These tests indicate the need for a mixture of grass and legume that will remain in a 30% alfalfa to 70% grass for repeated cuttings during the summer months. This was the chief failure of the brome-alfalfa mixture. The protein content of the mixture rose directly as the percentage of alfalfa in the mixture increased.

The mechanical grazing area was divided into two fields. When one field was completely grazed it was free flooded with four inches of irrigation water. The other field was treated similarly. The fields were given only one 4-inch irrigation application. An average mean temperature for the summer period of 66°F and a seasonal rainfall of 6.9 inches made possible the reduced irrigation. The fields were irrigated July 9-14 and 16-21 respectively.

The 10.67 acres under mechanical grazing produced 28,150 pounds of wet feed or 3.5 tons dry matter per acre.

Pasture Output in Terms of Beef Conversion

The steers showed an average weight gain of 2.03 pounds per head per day for the 89 day period. The two groups showed no significant difference in rate of gain. The weight gains remained somewhat constant over the summer period. The Control group averaged 2.04 lbs. gain per day and the implanted group gain per day 2.02 lbs. over the grazing period. The feed conversion was 7.69 pounds of dry matter per pound of beef produced with a stocking rate of 5.06 steers per acre. The beef per acre was 914.81 pounds. Waste was negligible.

Upon completion of tests the steers were graded according to Dominion Livestock standards. The hormone implanted group had substantially fewer animals in the "superior" group. The implanted group were equal in weight but due to the effect of the hormone, were not as advanced on finish as the control group. The Synovex - S gave no superior weight gains over the summer period. No significant correlation was found between beginning weights and weight gains.

Bloat Observation and Treatment

Bloat presented the greatest problem to a successful mechanical grazing operation. Brome-Alfalfa bloat is of the frothy-bloat type which builds up very quickly within the animal and if not released within minutes of buildup results in death of the animal. Bloat occurred 30 times in 89 days and a detailed account is given in table III.

The incidence of bloat appeared to be directly related to alfalfa percentage and usually occurred when the brome-alfalfa mixture contained more than 30-35% alfalfa. Mechanical grazing would not be considered a feasible operation under these circumstances.

TABLE I. PASTURE PRODUCTIVITY AND BEEF CONVERSION RATES OF MECHANICAL GRAZING TRIALS JUNE 4 TO SEPTEMBER 1, 1962
P.F.R.A., Predevelopment Farm, Outlook

Number of Steers mechanically grazed	54
Pounds of beef produced over M.G. period	9761
Pounds of green feed fed	300363
Pounds of green feed per pound of beef	30.77
Pounds of dry matter fed	75,090
Pounds of dry matter per pound of beef	7.69
Number of steers carried per acre Mechanical Grazing	5.06
Pounds of beef produced per acre	914.81
Percentage waste	.001

TABLE II. FREQUENCY, SEVERITY, AND TREATMENT OF BLOAT DURING MECHANICAL GRAZING PERIOD JUNE 4 TO SEPTEMBER 1, 1962
P.F.R.A. Predevelopment Farm, Outlook

Description over summer period June 4 to September 1, 1962		Number
Number of days on which bloat occurred		8
Total number of animals bloated	30	7 medium 14 serious 9 serious
Minimum number of animals bloated at one time		1
Maximum number of animals bloated at one time		9
Average number of animals bloated at one time		3.3
Number of animals injected directly into rumin		22
Animals drenched		1
Animals trocard following knife pierce		7
Animals pierced with knife		7
Animals complete recovery		29
Animals lost		1

Cost Analysis

The time and motion study of the mechanical grazing program was broken down into separate operations as

TABLE III. TIME AND MOTION STUDY OF MECHANICAL FEEDING OPERATION

P.F.R.A. Predevelopment Farm, Outlook

Operation	Time seconds	Time seconds	Average time seconds	Percentage of total
Assemble machinery	172	145	158.5	6.83
Travel to field	65	65	65	2.80
Cut alfalfa	562	585	573.5	24.72
Reteurn end of field to road	84	100	92	3.96
Travel to oats	109	107	108	4.65
Cut oats	93	104	98.5	4.24
Return travel to gate	150	151	150.5	6.48
Travel to yard	16	12	14	.60
Unhook and rehook	110	117	113.5	4.89
Travel to scale and weigh	65	55	60	2.58
Travel to feed yard	57	54	55.5	2.39
Unlatch wagon delivery	14	14	14	.60
Auger feed	340	304	322	13.88
Relatch wagon and remove PTO	35	30	32.5	1.40
Check cattle	90	95	92.5	3.99
Travel to yard	71	71	71	3.06
Time gain due to stopwatch supervision	300	300	300	12.93
Total	2333	2309	2320	100%
Total minutes	38.9	38.5	38.7	

TABLE IV. EXPENDITURES AND RECEIPTS OF MECHANICAL GRAZING OPERATION

P.F.R.A. Predevelopment Farm, Outlook

Expenditures	
Purchase of animals—54 @ $.23/cwt average weight — 581 pounds	$ 7,215.79
Yard feeding labour—60 hours @ $1.50	90.00
Labour time due to bloat — 45 hours @ $1.50	67.50
Miscellaneous labour — 40 hours @ $1.50	60.00
Land use cost* $65.87/acre 10.67 acres	702.83
Feed use cost $2.00/head	108.00
Non-bloat veterinary supplies and services	126.78
Bloat veterinary supplies and services	49.36
Synovex implants	91.15
2% margin for losses	144.32
Interest on investment — 6%/3 months	108.24
	$ 8,763.97
Receipts	
Sale of animals — 54 head @ $.22/cwt average weight — 761.7 pounds	$ 9,049.48
Manure returns — 375 tons @ $.75	281.25
	$ 9,330.75
Net balance	$ 566.78
Net balance per acre	53.12
Net return to overhead from land/acre from pasture rotation under Mechanical grazing — Net surplus+land charge / Number of acres	118.99
Net return to overhead from steers per head from pasture rotation under mechanical grazing — Net surplus+land charge / Number of steers	23.51

*Land use cost was drawn up by Professor Van Vliet, Head, Agricultural Economics Department, University of Saskatchewan. Opportunity cost of a ten-year rotation in operation at P.F.R.A. Predevelopment Farm, Outlook.

is shown in table IV. Although not mentioned in the study previously, the cutting of green oats in varying amounts was used to mix with the brome-alfalfa to reduce the overall percentage of alfalfa for purposes of combatting bloat. The large percentage of time spent in travel, 18.49%, compared to 28.96% of the total time spent in the cutting of green feed, indicates that location of the field must be considered in planning a grazing operation. Also, the relatively short time spent in the actual cutting of the forage illustrates that a much larger number of animals could have been fed with very little increased labour time. Mechanical grazing is especially well suited to a large feeder enterprise as the increase in returns with increased scale would be substantial. Difficulty is experienced in getting machinery small enough for a herd of 50 head.

The flail type forage harvester appeared to be very well suited to this type of operation. Only under extremely wet conditions such as cutting during or immediately following a rain was plugging of the machine a problem. The machine did a very clean job of harvesting the green forage and cutting it into desirable lengths for the livestock. The mechanical wagon proved very adaptable to the operation by cutting the feeding labour time down to a minimum and giving an even feed distribution with very little waste.

The actual feeding labour per animal per day was 1.41 minutes. The net balance per acre was $53.12 with a net return to overhead from land per acre from pasture rotation under mechanical grazing was $118.99. A net return to overhead from steers per head from the pasture rotation under mechanical grazing was $23.51. Cost details are shown in table 4.

SUMMARY

During the eight - nine day test period the average weight gain was 2.03 pounds per head per day. Hormone implants did not produce extra weight gains but did retard finish at the completion of the grazing period.

Bi-monthly field tests of the growing forage indicated that repeated harvesting under machanical grazing, caused a sharp rise in the alfalfa component with succeeding cuttings. This unfavourable aspect increased the danger from bloat (30 cases in 89 days).

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SEED TREATMENT WITH THE GRAIN LOADER*

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The grain loader, which is used extensively on farms for treating seed grain, was included in previous tests of farm type seed treaters (1), and the efficiency of fungicide application and uniformity of distribution were determined. These tests did not consider either the possible limitations of this equipment as to capacity during the treating process, or the effect of auger flight speed (rpm) on the quality of the treatment. Grain flow through a loader is seldom regulated to a known bushel-per-hour rate during farm seed treating operations, and since the loader itself does not provide a method for regulation, the accurate application of fungicide is possible only if some device is used to dispense a known quantity of grain within a time limit. Tests were conducted to determine at what rates of grain flow and at what auger speed the grain loader was most efficient as a seed treater.

The untreated grain was held in a hopper, and the grain flow, in bushels per hour, was varied by adjusting a calibrated orifice in the hopper bottom. A 6-inch grain loader, 10 feet long, powered by a 1-hp, 1750-rpm electric motor, was used to mix a liquid mercury fungicide of low volatility with the seed grain. The auger speed was varied by using four pulleys of different sizes on the auger shaft which gave speeds of 365, 445, 565 and 780 rpm under load. The fungicide was applied at the recommended rate of ¾ ounce per bushel, the correct volume being affected during any one test by a constant level reservoir. Wheat and barley were used as test grains. The arrangement of the equipment is shown in figure 1.

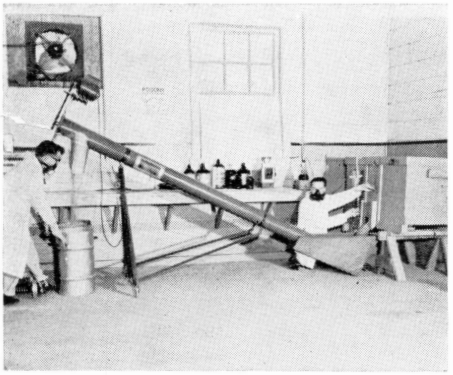

Figure 1. Arrangement of equipment showing grain loader, hopper and fungicide dispenser.

The tests consisted of a series of rates of grain flow from 30 to 600 bushels per hour in 30-bushel increments for wheat, and 50 to 600 bushels per hour in 50-bushel increments for barley. Each rate was treated at the four auger speeds. The assessment as to the efficiency of treatment and uniformity of fungicide distribution was made by a procedure already described (2).

The analysis of the results of treating wheat, in the range of 30 to 240 bushels per hour, showed that the efficiency of treatment and the uniformity of fungicide distribution were good and that differences in the quality of treatment were not significant at the four speeds ($P = 0.05$). At grain flow rates of 270 to 390 bushels per hour, a significantly poorer quality of treatment was produced at a speed of 365 rpm than at any of the other speeds. The most satisfactory quality of treatment was made at 780 rpm. The treatment of wheat at grain rates over 400 bushels per hour, at all speeds, was not satisfactory.

The quality of treatment with barley at 50 bushels per hour was not acceptable at any of the four speeds. In the range of 100 to 250 bushels per hour the efficiency of treatment and the uniformity of fungicide distribution were good at all four speeds, differences not being significant. At a rate of 300 bushels per hour a significantly poorer quality of treatment was made at 365 rpm, and at 350 bushels per hour only the treatments made at 565 and 780 rpm were satisfactory. The quality of treatment and uniformity of fungicide distribution at grain flow rates of 400 bushels per hour and over were not acceptable at any of the four auger flight speeds.

These results would indicate, then, that auger flight speed is not critical when treating seed wheat or barley at grain flow rates up to 250 bushels per hour. At higher rates than this, and up to 400 bushels per hour for wheat and 350 bushels per hour for barley, on auger flight speed of about 800 rpm should be used. Seed treatment at rates exceeding these is not recommended when using a 6-inch grain loader to apply fungicide to wheat and barley.

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Wet green feed production of 28,150 pounds per acre from the 10.7 acre field, produced 9,761 pounds of beef in 89 days. This is equivalent to 914.81 pounds of beef per acre (5.06 steers per acre) or 1.0 pounds of beef per 7.69 lbs. of forage (dry matter basis).

This mechanical grazing operation returned a value of $53.12 per acre over the returns from a ten year hay, cereal, potato rotation. The net return per head to overhead was $23.51.

ACKNOWLEDGEMENTS

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