Improvement of pastures by direct seeding into native grass in Southern Brazil with oats, and with nitrogen supplied by fertilizer or arrowleaf clover*

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RESUMO

Por um período de dois anos conduziu-se um experimento de pastagem de inverno para a avaliação de semeadura direta (sod-seeding) em pastagem nativa no estado do Rio Grande do Sul, Brasil. Foram comparados três tratamentos, de um hectare cada um, com duas repetições: 1) Testemunha (sem tratamento); 2) aveia (Avena sativa *L.) variedade 'Coronado', semeada diretamente, na qual aplicou-se 90 kg/ha de nitrogênio na forma de uréia; 3) aveia 'Coronado' semeada diretamente, tendo como fonte de nitrogênio, trevo "arrowleaf"* (Trifolium vesiculosum *Savi), semeado em mistura.*

A produção de forragem foi determinada através de amostras obtidas a intervalos regulares. A parte amostrada era mantida sob gaiolas. Os novilhos (resultantes de cruza entre o gado geral e Charolês ou Zebu) eram pesados no início, a cada 28 dias de intervalo e no final de cada ano de pastejo para determinação do ganho de peso. A média de ganho de peso, em kg/ha no final dos dois anos do experimento, foi: Testemunha 90,5, aveia mais nitrogênio 467,0, aveia com trevo 468,8. Ao analisar-se os dados sob o ponto de vista econômico deve-se levar em consideração que 6 kg de trevo tiveram o mesmo efeito que 90 kg/ha de nitrogênio, sendo, portando, mais econômico. Os animais, pastando durante todo o ano nestas áreas melhoradas, continuaram ganhando peso numa média bastante alta, inclusive durante o inverno, quando a maioria do gado perde peso; além disso, atingem idade de reprodução mais cedo e podem permanecer por mais tempo no rebanho como animais de cria. O gado de corte, neste sistema de melhoramento de pastagem através de cultivo mínimo, atingirá peso de abate mais rápidamente. — Os autores.

Introduction

THE need for winter feed for forage-consuming livestock is desperate in most of southern Brazil. Typically, grazing animals obtain their nutrients during this period from pasture herbage not used in summer. Most native grasses are dormant in winter and most are constantly overgrazed. The amount of pasture "residue" available to most grazing animals in winter is very meager and the consequent loss in weight and other losses are inevitable. Death losses of over 5 per cent per year are common and calving percentages are very low for animals on this low plane of nutrition. Also cattle are not usually ready for market until they are 4 to 5 years old.

The use of silage, hay, or improved winter pastures could provide a solution to this problem. However, hay-making is difficult in this climatic region having an annual rainfall of about 1400 mm (55-60 inches).

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The production and feeding of silage would be desirable if machinery and structures could become available at a price the farmers can afford. The use of winter pastures seems to be the best solution to this problem at this time. Again, this practice has not been generally adopted because of difficulties with tillage operations and economic considerations. The practice of devoting separate areas to winter and to summer pastures often means that these areas produce very little or nothing in the "off-season". Ryegrass and winter grains have been used when pastures have been seeded to provide winter grazing. These annual forage crops are valuable for this purpose but they do not grow in the summer and seeded fields often have only weedy species in the warm weather. This appears to be poor use of the pasture acreage and has led to a consideration of year-around grazing on the same land by a procedure known as "sod-seeding". This practice involves the direct seeding of these winter species into dormant perennial grass sods, with minimum cultivation and with machines that are capable of applying fertilizer and seed at specified depths in a once-over operation. The machines designed for this operation are heavy-duty drills which are being produced presently by several agricultural machinery companies in USA and at least one machine is now being manufactured in Brazil. Oats, *Avena sativa* L., is the most productive of winter cereals in this area of Brazil.

Much research has been conducted in the United States and Australia with sod-seeding (1, 2, 3, 4, 5, 7). The practice is most successful in regions with mild winters such as Southern United States and parts of Australia where cool season forages can be grown in the winter on land that grows perennial warm season forages in summer. Several experiments have been conducted in Rio Grande do Sul with a John Deere Grassland Drill. These trials showed that the practice had considerable promise and needed further research.

The research reported here was a field trial with grazing animals that has been conducted for two years. The increase in production from sod-seeding has been phenomenal and the trial has served as a useful demonstration. This is a report of a trial in which the native grasses which are dominant in natural pastures throughout southern Brazil were improved by two treatment combinations. The greatest limiting factor in these pastures appears to be nitrogen and consequently in this experiment some nitrogen was supplied to the improved pastures by the 10-30-10 starter fertilizer. Subsequently, the comparison was between the fertilizer supplied by fertilizer nitrogen (urea) in one treatment or from fixation by arrowleaf clover in the other.

Arrowleaf clover, *Trifolium vesiculosum* Savi, was first grown in this area in 1972 from seed imported from Alabama, where it has been used very successfully as a reseeding winter annual. It serves the same purpose as crimson clover, *Trifolium incarnatum* L., subterranean clover, *T. subterraneum* L. or bur clovers *Medicago spp*, except that it is later maturing and more productive.

Materials and methods

Six pastures, each 1 hectare in size, grazed in a put-and-take system of stocking management to evaluate two pasture improvement practices. The two treatments and the control were compared in two replications on an upland soil, São Geronimo, at the Experimental Farm at Guaiba, Rio Grande do Sul, Brazil. A soil test showed a need for phosphorus and potassium; the organic matter was low and the soil was acid.

The pastures treatments were superimposed on native grass vegetation, comprised mainly of native perennial warm season species. The area had been cultivated earlier but had been in pasture for several years. The pastures had been heavily grazed the year around, had not received fertilizer nor lime, and were badly infested with perennial weeds.

These pastures had been fenced, but it was necessary to provide a water system and feeders for salt and minerals. All livestock were excluded from the area at the time of planting and none was returned until pastures were stocked in mid-July. Therefore, pasturage was allowed to accumulate on all pastures during the period May 1 until July 15. This conserved feed accounts for some of the gains made by cattle in early winter.

This experiment attempts to evaluate pastures during all seasons of the year in the same areas. The only time that feed must be provided entirely by other means is during the period of about May 1 until mid-July when sod-seeded oats is making early growth. The oats can then be grazed heavily until November after which native grasses or native grasses and winter annual legumes continue to produce into summer. Native grasses produce until cool weather begins, at which time pastures are again sod-seeded to start another cycle of growth.

The following treatments were compared:

1. Control

This area was untreated except for an annual mowing. These experimental pastures represent quite well the average pastures in the area except that the mowing and grazing management used here are usually not practiced.

2. Sod-seeded oats cultivar 'Coronado', and arrowleaf clover (*Trifolium vesiculosum* Savi) cultivar 'Yuchi'

The pastures were seeded with 80 kg/ha of oats and 6 kg/ha of clover, and 200 kg/ha of 0-10-30 was applied at the same time, all with the John Deere Grassland drill in one operation. Another 200 kg/ha of 10-30-10 was applied broadcast. Nitrogen was supplied by the mixed fertilizer as a starter and later by the legume. Three tons of ground limestone per hectare were spread after seeding. (It was recognized that lime should be worked into the plow layer for best results, but there is no opportunity for this with the sod-seeding procedure. However, spreading the material after planting permits some of the lime to fall into the furrows

Table 1.—Yield of dry matter, (kg/ha) from native pastures untreated or sod-seeded. Guaiba, Rio Grande do Sul 1973-75.

Forage production[1/]	Native grass pastures					
	No treatment		Sod-seeded with oats, 400 kg/ha 10-30-10			
			Plus arrowleaf clover		Plus 90 kg/ha nitrogen	
	kg/ha					
"Winter"[2/]	1973-74	1974-75	1973-74	1974-75	1973-74	1974-75
Native grass	1161	1239	358	190	442	376
Oats	—	—	1267	824	2878	1983
Clover	—	—	1075	410	—	—
"Spring"						
Native grass	741	638	775	39	1399	555
Oats	—	—	60	245	995	1344
Clover	—	—	7377	2402	—	—
"Summer"						
Native grass	1557	906	1331	851	3686	4166
Oats	—	—	—	—	—	—
Clover	—	—	864	1747	—	—
"Autumn"						
Native grass	378	72	418	48	602	104
Oats	—	—	—	—	—	—
Clover	—	—	—	—	—	—
"Total herbage"						
Native grass	3837	2855	2882	1128	6129	5201
Oats	—	—	1327	1069	3873	3327
Clover	—	—	9316	4559	—	—
Total	3837	2855	13,525	6756	10,002	8528

1/ Content of weeds was determined but not included; they were of minor importance.

2/ See Table 2 for dates of the various seasons during these two years.

opened by the drill. In this way some lime should be in close proximity to the legume seed. Also, seedings in later years will tend to mix more soil and lime).

3. Sod-seeded oats with nitrogen fertilizer

This seeding was made in the same manner as N° 2, with nitrogen supplied both from the starter fertilizer at planting time and 90 kg/ha from urea applied in June. Another 45 kg/ha nitrogen from urea was applied in October to support native grass production in summer.

Forage production and botanical composition were determined on all pastures by the use of exclosures (pasture cages). Vegetation within the cages was harvested on a schedule that coincided approximately with the weigh periods of the cattle.

Yearling cross-bred heifers with an average weight of 151 kg were selected from the farm herd. They were weighed at the beginning of the experiment and at 28-day intervals, always after a 14-16 hour fast. A put-and-take system of stocking was used. Cattle grazed reserve pastures when not needed on experimental pastures, and were removed and returned as needed to utilize the pasture growth. No supplemental feed was provided, but mineralized salt and fresh water were available at all times.

Results

Forage production

The data for yields of weed-free dry matter are shown in Table 1. There were very few cool-season weeds but some warm-season ones appeared later, especially in the control pastures.

The production of native grass varied with the treatment and with the season. First harvest on Aug. 3 in the control pasture measured the growth of native grass produced after May 1 (1200 kg/ha) at which time improved pastures were sod-seeded and grazing was not permitted on any of the pastures until they were stocked on July 15. The total growth of native grasses on the control pasture for the year was 3346 kg/ha which supported animal maintenance and 91 kg/ha gain in weight.

The native grass contribution to the improved pastures was influenced by the degree of competition and the time of competition from other species. The oats and clover continued to compete over a longer period, for example, than the oats alone, and consequently the native grass in the former contributed much less.

The production of oat forage also was reduced by the competition from the clover in the oats-clover pastures and by the lower rate of nitrogen in this pasture compared to the oat pastures which received an additional 90 kg/ha nitrogen. This nitrogen not only stimulated heavy oat growth in winter but benefited the native grasses as well.

No oats were harvested after October 31. After that date the growth was either native grass or native grass and clover. The grand period of growth for the arrowleaf clover appeared to be approximately from the beginning of November to the end of December. During this time the grazing was managed so that some seed was produced to replenish the stand the following year. It is hoped that this legume will perform as a reseeding winter annual in this environment, as it does in southeastern United States. There should also be benefits derived from the decay of clover roots, crowns and nodules that may stimulate increased growth of grass in summer and fall.

Arrowleaf clover develops over a longer period of time than crimson clover or subterranean clover. However, in trials conducted at the same experimental station, arrowleaf clover was much more productive. If earlier growth is desired it may be possible to make seedings in early April. However, it may be more desirable to wait until the native grasses are in early dormancy. Much experimental work should be done to answer some of the questions about the use of this highly promising legume which has only recently been introduced into Rio Grande do Sul.

Animal performance

The gain in weight by seasons and the total gains for the four seasons are shown (Table 2). During the first weigh-period all cattle gained at the highest rate of the winter period. The cattle on control pastures gained an average of only 4.5 kg/ha; the forage that had been allowed to accumulate (1200 kg/ha) was available for grazing. (Normally, in winter, cattle graze pastures which were over-stocked the previous summer with no attempt by the farmer to save summer growth for grazing in winter). Only 689 kg/ha forage was produced in the spring on unimproved pastures. During this time the cattle were just maintaining or losing weight. Through the rest of the spring, gains were low and only in summer did they begin to make substantial gains.

Table 2.—Performance of beef heifers grazing unimproved and sod-seeded native pastures.[1/] Guaiba, Rio Grande do Sul 1973-75.

Performance	Native grass pastures		
	No treatment	Sod-seeded oats 400 kg/ha 10-30-10	
		plus arrowleaf clover	plus 90 kg nitrogen[2/]
Cattle Gains	kg/ha		
Winter[3/]			
July 17 - Oct 4 '73	13	150	291
July 4 - Sept 18 '74	—4	19	51
Spring			
Oct 5 - Dec 27 '73	0	188	72
Sept 10 - Dec 11 '74	41	241	189
Summer			
Dec 28 - Feb 20 '74	55	121	148
Dec 12 - Feb 2 '75	58	140	189
Autumn			
Feb. 21 - Apr. 17 '74	12	57	—13
Feb 3 - Apr 17 '75	6	18	10
Total for year			
1973-74 (304 days)	80	516	498
1974-75 (315 days)	101	418	439
2 year av	90.5	467.0	468.5

1/ Grazed by yearling beef heifers with "put and take" system of stocking. All weights obtained after 14-16 hours of fasting without feed or water.

2/ On Oct. 25, 1973 an additional 45 kg/ha N was applied to the sod-seeded oats plots that did not have clover. This was to support summer native grass growth.

3/ These designations of seasons are approximations. Cattle were weighed at 28 day intervals after over night shrink.

Those cattle grazing the sod-seeded oats and clover produced less in winter than those grazing nitrogen-fertilized oats probably because the clover was slow in growth and nitrogen was limiting sometime during the season. (This legume starts from a smaller seed and reaches maturity over a longer period of time than oats). The cattle gained more in spring than those grazing oats with nitrogen because of the late growth of the clover.

Cattle grazing sod-seeded oats with nitrogen supplied by urea, gained about as much as those grazing oats and clover over the spring and summer period. They gained less in the autumn than those in pastures that had clover. Apparently, the benefits of the clover lasted into the late summer and autumn when dry weather limited the utilization of fertilizer nitrogen.

Results for the two year period show that the pastures, improved with sod-seeding, produced more than five times as much beef as those with no improvement. Actually, the grazing management on the no treatment pastures was an improvement over the average unimproved pasture in the area since these pastures had a period of uninterrupted growth each year during April and May and the stocking rate was regulated.

Since the gains were the same for the two improved pastures the choice of one system over the other would depend upon the cost of the 90 + 45 kg/ha of nitrogen from urea in one case and the cost of the 6 pounds of arrowleaf clover in the other. Other expenses are the same for the two systems. Obviously, the cost of the clover seed in much less and one can expect some seed to shatter to replenish stands in later years and seed will be set regularly in the ungrazed areas around manure spots. Under careful management the stands can be expected to reseed themselves regularly, but annual reseeding may be good insurance at least for the first few years until a supply of seed is built up in the soil.

Conclusion

A grazing experiment was conducted to evaluate direct-seeded (sod-seeded) oats into winter dormant native grass pastures, with nitrogen supplied either by a winter annual legume or by fertilizer. The treatments were evaluated by grazing yearling heifers and by forage samples harvested under pasture cages. Results of the two years of a trial which is designed to continue into other years may be summarized as follows:

1. Average live weight gains (kg/ha) for the period, July 14, 1973 to April 17, 1974 and July 4, 1974 to April 17, 1975 were: 1) control - 90.5, 2) sod-seeded oats with nitrogen supplied by arrowleaf clover 467.0, and 3) sod-seeded oats with nitrogen supplied by fertilizer 468.5.

2. The largest winter gains were produced by the pastures which were sod-seeded with oats and supplied with nitrogen at the rate of 90 kg/ha in addition to that supplied by 400 kg of 10-30-10 as a starter fertilizer.

3. The largest gains in spring were produced on pastures sod-seeded with oats and arrowleaf clover. Average daily gain for this treatment was highest among all pastures at 593 grams (1.3 lb) over a 295 day period in the first year of the trial.

4. Cattle grazing the control pastures gained only an average of 4.5 kg per head during the winter periods. Most cattle grazing native pastures in southern Brazil lose weight during this period because they must continue to graze pastures which are continuously and closely grazed throughout the year. The control pastures, in this case, had an accumulation of 1200 kg/ha of grass which was ungrazed in the May-July period. This practice of deferred grazing offers considerable promise on many farms.

5. Arrowleaf clover proved to be very productive and well adapted to the region and to the practice of sod-seeding. Seeded at the rate of 6 kg/ha, on the surface, in the trenches over the sod-seeded oats, the clover alone produced the following average amounts of dry matter (kg/ha): "winter" *743*, "spring" *4889*, and "summer" *1306*, total *6939*. The stocking rate was regulated so that some seed was produced and allowed to shatter to reestablish the stands. This legume has performed well in Alabama, U.S.A. Hoveland *et al.* (6) obtained yields of 7300 kg/ha when arrowleaf clover, cultivar "Yuchi", was cut biweekly until early April followed by a cutting for hay in late May. This paper reviews the literature on the favorable potential of this winter annual forage legume for subtropical environments.

6. Sod seeding appears to be a very practical method for providing winter feed in Rio Grande do Sul. Grassland drills, imported or manufactured locally are multiple-use machines, and may be adapted for distributing seed and fertilizer on prepared seedbeds as well. The native grasses in sod-seeded pastures can be expected to benefit by this procedure, and year-around grazing on a higher production level is possible without subjecting sloping land to soil erosion.

7. With good winter pastures it has been possible to market fat cattle in the spring when these cattle bring a very high price because there is practically none available in the country. This is another very important advantage for this program and a strategy that could pay good dividends.

8. An economic analysis of these data should include the added value of the highly nutritious winter feed. This can be translated into better health of the animals and shorter time to breeding age and to market.

Summary

An experiment to evaluate direct seeding (sod-seeding) as a means of providing winter forage for beef cattle in Rio Grande do Sul was conducted over a two-year period at Guaiba near Porto Alegre, Brazil.

Cross bred beef heifers were used to measure gains in weight from replicated native pastures of one hectare each. These treatments were compared: 1) control-no treatment, 2) sod-seeded oats, *Avena sativa* L., and arrowleaf clover, *Trifolium vesiculosum* Savi, and 3) sod-seeded oats plus 90 kg/ha of nitrogen from urea. Sod-seeded pastures received a total of 400 kg/ha 0-10-30 and three tons of ground limestone per hectare. Cattle were weighed on 28-day intervals throughout the four seasons and total gains for the year, (not including the May 1 to July 15 period when oats and clover were starting to grow) were used to evaluate the sod-seeding practice.

The results for the two years showed that whereas the control pastures produced 90.5 kg/ha gains, the oats and arrowleaf clover pastures produced 467.0 kg/ha and the oats and 90 kg/ha of nitrogen from urea produced gains of 468.5 kg/ha. In addition to the five-fold increase in gains this practice reduces the time required to grow cattle to breeding age or to market grade.

Resumen

Se llevó a cabo en un período de dos años en Guaiba, cerca de Porto Alegre, Brazil, un experimento para evaluar el sembrío directo (sod seeding) como medio de suministrar forraje de invierno para el ganado de carne en Rio Grande do Sul.

Se usaron vaquillas cruzadas de carne para medir las ganancias en peso de pastizales repetidos de una hectárea cada uno. Se compararon estos tratamientos: 1) testigo sin tratamiento; 2) avena, *Avena sativa* L. y trébol hoja de flecha, *Trifolium vesiculosum* Savi sembradas directamente; y 3) avena sembrada directamente más 90 kg/ha de nitrógeno en urea. Los pastizales sembrados directamente recibieron un total de 400 kg/ha de 0-10-30, y tres toneladas de piedra caliza molida por hectárea. Los animales se pesaron a intervalos de 28 días durante todas las cuatro estaciones y los aumentos de peso para el año (sin incluir el período del 1º de mayo al 15 de julio cuando la avena y el trébol estaban comenzando a crecer) se usaron para evaluar la práctica de sembrío directo.

Los resultados para los dos años mostraron que mientras los pastizales testigo produjeron aumentos de 90,5 kg/ha, los pastizales con avena y trébol produjeron 467,0 kg/ha y la avena con 90 kg/ha de N-urea produjo aumentos de 468,5 kg/ha. Además del aumento cinco veces mayor, esta práctica reduce el tiempo que necesita crecer el ganado hasta la reproducción o para alcanzar el grado para el mercado.

Literature cited

1 BLACKMORE, L. W. Overdrilling of pastures and crops. New Zealand Journal of Agriculture 96:17-25. 1958.

2 COATS, R. E. Sod-seeding-Brown Loam Tests. Mississippi Agricultural Experiment Station Bulletin 554. 1957.

3 DECKER, A. M., REITZER, H. J., SWAIN, F. G., and DUDLEY, R. F. Midland bermudagrass forage production supplemented by sod-seeded cool season annual forages. Maryland Agricultural Experiment Station Bulletin 484. 1969.

4 DERSHEID, L. A., MOORE, R. A., and RUMBAUGH, M. D. Interseeding for pasture and range improvement. FS 422. Agricultural Extension Service, South Dakota State University. 1970.

5 FRIBOURG, H. A. and OVERTON, J. R. Forage production on bermudagrass sods overseeded with tall fescue and winter annual grasses. Agronomy Journal 62: 295-298. 1973.

6 HOVELAND, C. S., McCORMICK, R. F., and ANTHONY, W. B. Productivity and forage quality of Yuchi arrowleaf clover. Agronomy Journal 64:552-555. 1972.

7 WHELLER, J. L. and CAMPBELL, M. H. The potential for winter grazing from sod-seeded cereals in southern Australian. Australian Journal of Experimental Agriculture, Animal Husbandry 9:584-588. 1969.