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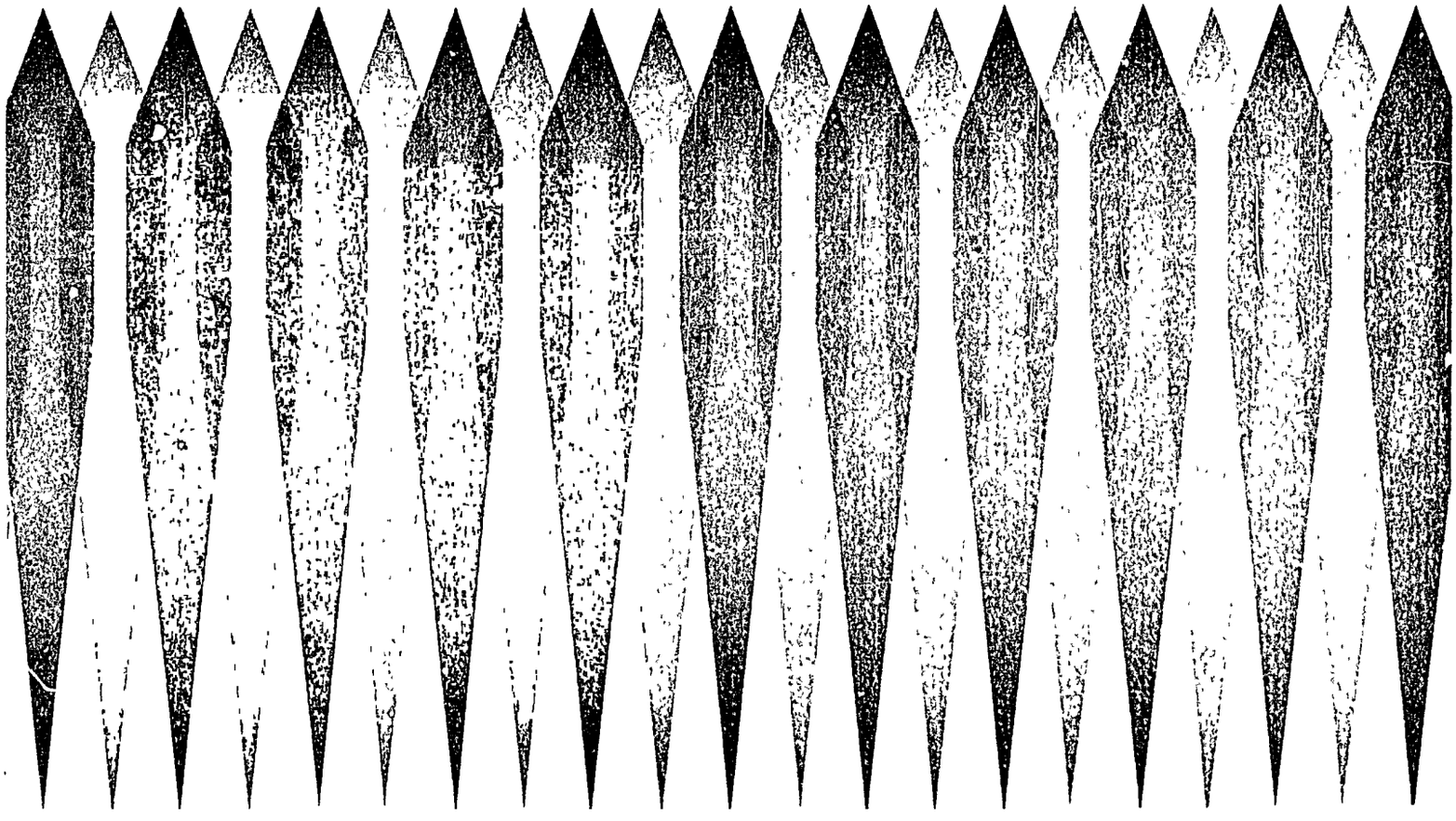

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FOREWORD

Nutrition for Tropical and Subtropical Pastures is one of a series of bibliographies being prepared at the request and with the financial support of the Agency for International Development. A basic goal is to make available the most recent literature published on this crop, particularly in regions where library facilities are limited or absent.

Tropical pasture science is of fairly recent origin and information on which to base practical advice is only now becoming available The most vital link in the chain of communication is that between the research group and the advisory service. Hopefully, this abstract bibliography will facilitate communication between the two. All references were selected from primary or secondary sources in the Technical Library of the National Fertilizer Development Center.

Within the bibliography the abstracts are arranged by large geographical areas and within areas, alphabetically by country in which the work was done, or the country in which the work was published

Nutrition for Tropical and Subtropical Pastures would not have been possible without the cooperation and assistance of many individuals and organizations Several institutions were particularly helpful in furnishing information and in permitting use of abstracts from their publications. They and their identifying notations are:

1. The Commonwealth Agricultural Bureaux (publishers of *Soils and Fertilizers*, shown as Soils Fert.)
2. Chemical Abstracts Service (shown as CA)
3. Royal Tropical Institute, Amsterdam (shown as Trop. Abstr.)

Other abstracts were taken from TVA's *Fertilizer Abstracts* (shown as FA).

TABLE OF CONTENTS

Africa 3
- Kenya 3
- Madagascar 3
- Nigeria 3
- Rhodesia 4
- South Africa 5
- Tanzania 6
- Uganda 6
- Zambia 7

The Americas 7
- Brazil 7
- British Honduras 8
- Colombia 9
- Costa Rica 10
- Cuba 11
- Guyana 11
- Haiti 12
- Jamaica 12
- Mexico 12
- Puerto Rico 13
- Trinidad 14
- United States 14
- Venezuela 19
- Virgin Islands 20

Asia and Australia 20
- Australia 20
- Burma 30
- India 30
- Israel 31
- Sri Lanka 32

Books and Reviews 32

List of Publications 33

Author Index 34

Subject Index 36

KENYA

1 Experimental Studies on Seed Production of Tropical Grasses in Kenya. III. The Effect of Nitrogen and Row Width on Seed Crops of *Setaria sphacelata* Cultivar Nandi II. J. G. Boonman (Nat. Agr. Res. Sta., Kitale, Kenya). *Neth. J. Agr. Sci. 20* (1), 22-34 (1972). *Trop. Abstr. 27*, 2680. The effects of N levels from 0 to 260 kg/ha and varying row widths were studied in two field experiments over 5 yr. Pure germinating seed (PGS) and dry matter were increased seven- and threefold, respectively, by applying 100 kg N/ha. Top N levels tended to decrease percentage and yield of PGS, especially at wide row widths. At 130 kg N/ha, 30 cm wide rows produced 30% higher PGS yields than 90-cm rows, resulting from more concentrated heading and flowering at close row width. Percentage and yield of PGS varied widely from season to season although dry matter yields and head numbers varied little. Herbage dry matter yields were on the average increased by 6.5 tons by application of 100 kg N/ha.

2 Experimental Studies on Seed Production of Tropical Grasses in Kenya. IV. The Effect of Fertilizer and Planting Density on *Chloris gayana* cultivar Mbarara. J. G. Boonman (Nat. Agr. Res. Sta., Kitale, Kenya). *Neth. J. Agr. Sci. 20* (3), 218-24 (1972). *FA 6*, 477. The effects of P in the seed bed (0-80 kg P_2O_5/ha), N(0-200 kg N/ha), seed rate [0.2-1.8 kg pure germinating seed (PGS)/ha], and row width (broadcast planting–100 cm) were studied each at five levels over 4 yr in a central composite design. In the establishment crop, P failed to affect any yield aspect, while seed rate reduced yield of clean seed and number of heads but increased yield of dry matter significantly. Seed rate and row width did not affect yield of PGS significantly. Row width decreased yield of dry matter. In the six post-establishment crops, N was the only factor that was important for seed yield. By applying 100 kg/ha yield of PGS was increased more than sixfold, to 41 kg/ha at a row width of 50 cm. Yield of PGS was highest at 25 cm row width and 150 kg N/ha, but the effect of row width was not significant. Row width, however, increased yield of dry matter and number of heads. Increases in N and row width accelerated the onset of heading.

3 Productivity of Grass and Grass/Legume Swards in the Kenya Highlands. J. Morrison. *East Afr. Agr. Forest. J. 32* (1), 19-24 (1966). *Trop. Abstr. 22*, 307. Plots of *Dactylis glomerata* receiving 0, 560, and 1120 kg calcium ammonium nitrate/yr, and plots of this grass mixed with *Trifolium subterraneum, T. repens* or both were compared in a trial conducted in Kenya on a poor soil at an altitude of 2700 m during 2 yr. All plots received P fertilizers. *T. subterraneum* failed to develop satisfactorily on account of adverse rainfall conditions. Both the N fertilizer and *T. repens* increased the grass yields. Plots of the grass/white clover mixture in the 2nd yr showed a total forage yield about as high as that of grass plots receiving the higher rate of N fertilizer, and their forage had a higher protein content. The legume appeared able to fix about 225-340 kg of atmospheric N/ha/yr.

4 The Effect of Single Superphosphate on the Yield and Chemical Composition of a Grazed Grass/Legume Pasture at Kitale, Kenya. J. M. Suttie (Dep. Agr., Nairobi, Kenya). *East Afr. Agr. Forest. J. 35* (4), 359-63 (1970). *FA 4*, 167. A grazed pasture of Nandi Setaria and Kenya wild white clover showed marked responses to single superphosphate. An adequate dressing for establishment is 300 kg/ha; annual top dressings of 200 to 300 kg of single superphosphate are recommended. Split application as opposed to applying heavy dressings in the seedbed led to more efficient fertilizer use. Yields of dry matter were well below the levels attained in clipping trials in Kenya but are in agreement with the stocking rates attained in practice. The application of single superphosphate also improved the N and P content of the herbage.

5 The Contribution of *Desmodium uncinatum* to the Yield of *Setaria sphacelata*. D. M. Thairu (Nat. Agr. Res. Sta., Kitale, Kenya). *East Afr. Agr. Forest. J. 37* (3), 215-19 (1972). *Trop. Abstr. 28*, 368. Trials over 4 consecutive yr evaluating productivity of *Desmodium/Setaria* mixtures conducted in Kenya, showed that total yields of dry matter and of N in these mixtures were considerably higher than those of grass alone without added N. Mean production values of the mixtures over 4 yr for each of the five harvests/yr varied from 1700-2500 kg/ha compared to 1000-1700 kg/ha for the untreated grass control. Nitrogen yield of the grass component was increased by some 10-25% in the presence of the legume, whereas addition of 200 kg N/ha to grass alone gave a fourfold increase in 3 yr out of 4.

MADAGASCAR

6 Fertilizer Trial on *Chloris gayana*. Huynh-Van-Nhan (Sect. Agron. O.R.S.T.O.M., Tananarive, Madagascar). *Terre Malgache 9*, 133-65 (1971) (Fr). *Trop. Abstr. 27*, 392. Results are presented of a field trial laid out in a farm site in Madagascar consisting of a poor ferrallitic upland soil under *Chloris gayana* fodder grass cover. The effects of mineral fertilizers, alone and in addition to organic manure, and of liming were studied. The results demonstrated the important role of organic manure. The best results, both from the fodder production and the economic points of view were obtained with the application of organic manure in combination with dolomitic lime (50 tons/ha and 1 ton/ha, respectively); an additional low rate of NPK-fertilizer applied 1 yr later, maintained fodder yield at a satisfactory level.

NIGERIA

7 Effects of Cutting Frequency and Level of Applied Nitrogen on Productivity, Chemical Composition, Growth Components, and Regrowth Potential of Three *Cynodon* Strains. J. O. Akinola *et al. West Afr. J. Biol. Appl. Chem. 14* (2), 7-12 (1971). *Trop. Abstr. 27*, 134. In Nigeria, field trials showed that energy reserves of *Cynodon* species, as measured by regrowth in the dark, were significantly affected by frequency of cutting, level of N application, and genotype of strains. Regrowth potential was also affected by seasonal variations. Nitrogen applied at 170 kg/ha in conjunction with 112 kg P_2O_5/ha as single superphosphate and a cutting interval of 6 weeks gave the highest dry matter yield under field conditions, and was significantly and positively correlated with regrowth values of the sod.

8 Nutrient Requirements of Tropical Pasture Legumes. I.

Influence of Soil Type and Nitrogen Levels on the Growth, Nodulation and Nitrogen-Fixation of *Centrosema pubescens* Bent and *Stylosanthes gracilis* L. A. A. Fayemi, C.T.I. Odu, and A. Fagbami. *Nigerian J. Sci. 4* (1), 67-75 (1970). *Trop. Abstr. 26*, 2857. In Nigeria, pot experiments showed that the dry matter yield of *C. pubescens* increased in the loamy sand soil, but decreased in the sandy loam soil, with increased N levels (from 10 to 80 ppm). The dry matter yield of *S. gracilis* was generally not affected by N levels or soil types. Effects of the treatments on root yields and N contents of both legumes are discussed. In both soils, the nodule number of both legumes significantly decreased with increased N levels. Nitrogen fixation consistently decreased with increased N levels. Both legumes fixed more N in the sandy loam than in the loamy sand soil.

9 **A Guide to the Management and Use of Stylo (*Stylosanthes gracilis*).** R. J. Haggar. *Samaru Agr. Newslett. 11* (6), 63-6 (1969). *Trop. Abstr. 26*, 1477. The proper cultivation methods of stylo in Nigeria are outlined. The legume can be successfully grown in combination with *Andropogon gayanus* (gambagrass), *Panicum maximum* (guineagrass), and *Chloris gayana* (rhodesgrass) to provide useful grass and legume pastures for wet-season grazing. Such mixtures should be grazed rotationally every 6-8 weeks and 125-250 kg superphosphate/ha should be broadcast annually. The mixtures do not need N fertilizers. A good quality silage can be made from stylo, but it is not suitable for hay-making. When cut and dried, stylo can be ground into high quality meal. A brief note is given on *S. mucronata* and on *S. humilis* (Townsville lucerne), which is particularly suitable for the drier areas.

10 **The Production of Seed from *Andropogon gayanus*.** R. J. Haggar. *Samaru Res. Bull. 80*, 1-9 (1967). *Trop. Abstr. 24*, 115. Field studies with the grass *Andropogon gayanus* were conducted in North Nigeria to study the effect of some agricultural practices on the yields of seed. Tillers formed before the beginning of the wet season produced most of the inflorescences. High yields of seed can be obtained, therefore, by encouraging the production of tillers during or before the start of the wet season. Grazing after mid-June greatly reduced the number of flowering tillers. The average height, number, and size of inflorescences were increased by N fertilizers at rates exceeding 55 kg N/ha. Yields of seed were increased two- and threefold by rates of 112 and 224 kg N/ha, respectively. Delaying harvesting until after early November resulted in large losses of seed. The possibilities of mechanical seed harvesting are discussed.

11 **Responses of Grasses and Legumes to Fertilizer Treatments in Nigeria.** G. P. Tewari. *Exp. Agr. 4* (1), 87-91 (1968). *Trop. Abstr. 23*, 994. In East Nigeria, 2 *Panicum maximum* cultivars from Kenya, *Centrosema pubescens*, and *Stylosanthes gracilis* were grown alone and in mixtures during 2 yr. When grown alone, *P. maximum* cultivar Liconi was much more productive than cultivar Sabi, and *S. gracilis* was much more productive than *C. pubescens*. PK and NPK fertilizers had rather erratic effects; NPK fertilizer generally resulted in the highest yields except with legumes in pure stands. With NPK fertilizers, the highest total dry matter yield (39.5 ton/ha) was obtained from a pure stand of the grass cultivar Liconi; yields of 29-33 ton/ha were obtained from plots with one or both legumes + cultivar Liconi and from plots with both legumes + cultivar Sabi. The proportion of legume in the harvest was very low in *C. pubescens* + cultivar Liconi plots, very high in plots with both legumes + cultivar Sabi.

RHODESIA

12 **Improved Pastures in Vleis.** D. L. Barnes. *Rhodesia Agr. J. 64* (6), 126 (1967). *Trop. Abstr. 23*, 773. For improvement of pastures on vleis in the sandveld region of Rhodesia, the introduction of four grasses, namely: (1) *Acroceras macrum* (Nile grass); (2) *Panicum repens*; (3) *Brachiaria* sp. nr. *mutica* (Tanner grass); and (4) *Paspalum urvillei* (upright paspalum) was found to be advantageous. Brief data on growth and cultivation characteristics, nutritive value, etc. of these grasses are given. While liming of the usually very acid vlei soils so far has not been effective, P fertilizing at a rate of 336-448 kg superphosphate/ha, applied before planting, is essential to obtain good growth. For high production, N fertilizing is also a prerequisite. With the grasses sub (1) and (2), and possibly also (3), plowing or disking every few yr may be desirable for reestablishment of the pasture.

13 **Irrigated Pastures.** D. L. Barnes. *Rhodesia Agr. J. 67* (6), 154-9 (1970). *Trop. Abstr. 26*, 2000. In Rhodesia, four categories of irrigated pastures are distinguished, namely: (1) short-term winter pastures of cereals or ryegrass grown with or without annual legumes; (2) lucerne; (3) pastures of perennial temperate-region grasses grown with or without temperate-region legumes; and (4) pastures of perennial tropical grasses grown with or without tropical legumes. Fertilizing, sowing, and management of each of these categories is treated. Special attention is paid to irrigation and ways to use the green feed for livestock.

14 **Results of Grazing Paraguay and Beehive Paspalums.** J. N. Clatworthy. *Rhodesia Agr. J. 65* (2), 36 (1968). *Trop. Abstr. 23*, 1859. *Paspalum notatum* and *P. plicatulum* have shown promise as pasture in Rhodesia; the prostrate stoloniferous *P. notatum* is best suited for leys, the bunch grass *P. plicatulum* for permanent pastures. A 0.23-ha field of each species was established at Grasslands Research Station in Nov. 1963; in 1964-65 and 1965-66, 225 kg superphosphate and 84 kg KCl/ha were applied before the rains, 560 kg calcium ammonium nitrate was applied in 3 equal applications during the rains. From Dec. 15, 1964, to Apr. 20, 1965, and from Nov. 23, 1965, to June 21, 1966, the fields were alternately grazed by two yearling Afrikaander steers. Average liveweight gains/ha were 585 and 560 kg, respectively; this leaves a profit over the cost of fertilizers.

15 **The Effect of Applying Nitrogen in Various Ways on the Herbage Yield of Giant Rhodesgrass (*Chloris gayana* Kunth).** M.G.W. Rodel. *Rhodesia Agr. J. 66* (2), 43-5 (1969). *Trop. Abstr. 25*, 1655. Field trials with rhodesgrass (*Chloris gayana*) conducted in Rhodesia in 1965-66 and 1966-67 showed that four split dressings, each applied at 112.5 kg N/ha at four weekly intervals, and in the presence of dung at a rate of 25 tons dry matter/ha, gave the highest dry matter yields. Yields of some 18 and 19 tons/ha were obtained in the respective yr, which were significantly higher than the yields obtained after a single dressing of 450 kg N/ha early in the seasons, which were some 16 and 17 tons/ha. Dung significantly increased dry matter yields by some 2.2 and 1.8 tons/ha in the respective yr.

16 **Effects of Four Minor Elements on the Herbage Yields of Stargrass on Granite Sandveld Soil.** M.G.W. Rodel. *Rhodesia Agr. J. 68* (2), 32-3 (1971). *Trop. Abstr. 26*, 2846. In Rhodesia, the application of S, B, Zn, and Mg had no effect on the herbage yields of stargrass, *Cynodon plectostachyus*, grown on granite sandveld soil. Plots which received no Mg

were dressed with calcitic limestone, while Mg was supplied as dolomitic limestone to other plots in equivalent amounts with respect to neutralizing value (560 kg/ha, 12% Mg). Sulfur was supplied, where appropriate, as single superphosphate at 270 kg/ha, containing 12% S. Zinc was applied as zinc sulfate at 22 kg/ha, containing 22.7% Zn, and B as fertilizer borate at 11 kg/ha, containing 14.3% B. Herbage yields were low in comparison with those obtained on a relatively silty, fersiallitic clay on the same station. The reason for this difference might have been due to damage caused by soil nematodes to the grass root system.

17 Recent Pasture Research at Henderson Research Station. M.G.W. Rodel and J. N. Boultwood. *Rhodesia Agr. J. 64* (1), 16-20 (1967). *Trop. Abstr. 22*, 1168. Grazing experiments conducted in Rhodesia showed that by heavy N fertilizing at a rate of 270-340 kg N/ha, pastures of giant rhodesgrass (*Chloris gayana*), *Cynodon plectostachyus*, and *Panicum repens* can be stocked in summer at a rate of 4.5-5.6 230-kg steers/ha, resulting in liveweight increases ranging from 60-80 kg/steer. There was a marked difference between these grasses in their ability to produce liveweight gains and also to withstand intensive grazing; the best results were obtained with *P. repens*. It appears that pastures used intensively in this way improve in vigor and basal cover, resulting in a possible extension of their productive life. Steers fed a supplement of maize and cob meal while grazing intensively on such heavily fertilized pastures gained considerably more in liveweight than did those without maize supplement.

SOUTH AFRICA

18 The Effect of Applying Biuret to Certain Grasses. R. E. Altona and G.F.S. Hyam (Afr. Explos. Chem. Ind. Ltd., North Rand, S. Africa). *Grassl. Soc. S. Afr., Proc. 5*, 91-3 (1970). *FA 5*, 266. Annual applications of 132.4 kg N/ha as crude biuret dust or granules to a 5-yr-old sward of *Eragrostis curvula* in 1965-67 caused slight burning of the leaf tips, increased hay yield from 1.16-1.48 ton/ha in plots given no N to 5.71-6.78 ton and increased the crude protein content of the herbage from 5.3-5.8% (no N) to 6.4-9.3%.

19 Lime and Molybdenum in Dry-Land Lucerne in the Southern Cape Coastal Region. C. P. Beyers. *Farming S. Afr. 42* (12). 49-50 (1967). *Trop. Abstr. 22*, 1396. Good yields of dry-land lucerne in the southernmost part of the Rep. of S. Africa often depend on applications of lime and molybdenum. Molybdenum should be applied at a rate of 0.35 kg/ha Na molybdate either to the seed or to the foliage. For seed treatment, 100 kg of seed should be wetted with a solution of 625 g molybdate in 3.6 liter water and turned over; the process is repeated until all the liquid is taken up. Inoculation with *Rhizobium* may be done at the same time. For foliar spraying, the required amount of molybdate is applied in 225-2000 liter water/ha when the crop is in an active stage of growth; spraying is repeated after 1-2 yr when the lucerne again starts showing an abnormally yellow color. Lime should be applied at 2-3 tons/ha.

20 Lime, Molybdenum, and Copper for Dryland Lucerne in the Winter Rainfall Region. C. P. Beyers. *Agroplantae 1* (1), 13-18 (1969) (Eng). *Trop. Abstr. 25*, 2958. The influence of lime, Mo, and Cu on yield and composition of dryland lucerne was studied on 13 soils in the Rep. of S. Africa. Yield increases due to the amendment of each of these elements, and the increase of Mo and decrease of Cu in the lucerne due to lime application, are discussed.

21 Molybdenum in Dryland Lucerne—How Much and How Often. C. P. Beyers. *Farming S. Afr. 43* (4), 11 (1967). *Trop. Abstr. 22*, 2516. Trials with lucerne on Mo-deficient soils in the southern part of the Rep. of S. Africa demonstrated that seed treatment or foliar spraying with sodium molybdate at a rate of 140 g/ha was sufficient to rectify the deficiency and to maintain a satisfactory Mo content of around 0.5 ppm in the crop for at least 1 yr. Application of 280 g $NaMoO_4$/ha to the soil at the time of crop establishment was sufficient for at least 2 yr.

22 Fertilizing Natural Veld on Red Loam Soil of the Springbok Flats: Effect of Ammonium Sulfate and Superphosphate on Dry Yield and Mineral Content. A. J. Louw (Landbounavorsingsinst. Transvaalsteek, Pretoria, S. Africa). *S. Afr. Tydskr. Landbouwetensk. 11* (4), 629-36 (1968) (Afr). *CA 71*, 21282. Natural veld on the Springbok flats yielded a mean of 1.16 tons air-dry material/morgen for the P_0N_0 level, and 5.77 tons/morgen for the P_2N_4 level of fertilization. Percentage and yield of crude protein increased significantly with increased levels of $(NH_4)_2SO_4$ and superphosphate. At fertilizing levels of P_0N_0 and P_2N_4 yields were 129.23 and 1461.47 lb/morgen of crude protein, respectively. Phosphorus content of veld hay increased significantly with increased level of fertilization; with the P_2N_4 level of fertilization P yield was 54.17 lb/morgen, the control was only 4.69 lb/morgen. Percentage N regained in herbage increased with increased NP levels.

23 Fertilization of *Eragrostis curvula* in East Griqualand. P. M. Miller. *Farming S. Afr. 45* (3), 26-8 (1969). *Trop. Abstr. 25*, 356. The general principles concerning the fertilizing of lovegrass (*Eragrostis curvula*) in E. Griqualand, Rep. of S. Africa, as well as general recommendations regarding lime, N, P, and K fertilizer levels are discussed. It is concluded that, if these principles are adopted with the inevitable little variations for specific circumstances, the value of the grass as a fodder and ley crop will be markedly improved. This hardy perennial grass will not only produce large quantities of material for grazing and of high quality hay, but will greatly contribute to reduced exploitation of arable land as well, making a significant contribution to agriculture in the country both in the long and short run.

24 The Fertilizer Requirements and Yield Potential of Forage Crops Grown on Soils Formerly Planted to Sugarcane. E. P. Theron. *South Afr. Sugar J. 51* (7), 579, 581, 583, 585, 587 (1967). *Trop. Abstr. 22*, 2294. In the Natal coastal belt, nine trials with various pasture species were conducted for 2-4 yr. *Chloris gayana* and *Pennisetum clandestinum* gave disappointing results; *Paspalum dilatatum* and lucerne proved to be well suited to the region both with and without supplementary irrigation, promising annual yields of over 16 tons of dry matter/ha with adequate fertilizer applications. On land formerly planted to sugarcane, *P. dilatatum* responded well to calcium ammonium nitrate and to superphosphate; K fertilizer will probably be needed after a few yr at least when the pasture is not grazed. Requirements of lucerne are less clear, an unexpected response to N being probably due to ineffective inoculation with *Rhizobium*, but Ca and P applications appeared to be essential.

25 Fertilization of Vlei Pastures. D. A. von Berg. *Farming*

S. Afr. 42 (8), 37, 39, 41 (1966). *Trop.Abstr. 22*, 521. A series of fertilizer trials conducted in the Drakensberg area of Natal in 1965-66 showed that hay yields of pastures on vlei soils may be considerably improved by application of dolomitic limestone, more or less independently of other fertilizer applications. It is expected that liming every 6 yr will be sufficient; in that case it was remunerative in all trials. Application of N fertilizer was beneficial but not always profitable; application of superphosphate either alone or in combination with N fertilizer had but little effect on yields.

26 Effect of Potassium Fertilizer in the Presence of High Nitrogen Applications on the Hay Yields and Chemical Composition of *Eragrostis curvula*. L. F. Vorster. *Republ. South Afr. Dep. Agr. Tech. Serv., Tech. Commun. 63*, 1-9 (1967) (Afr). *Trop. Abstr. 23*, 779. Plots of an *Eragrostis curvula* ley at Pretoria annually received 160 or 320 kg N, 0 or 25 kg P, and/or 0, 50, or 100 kg K/ha. The mean hay yield over 10/yr was lowest (6.36 ton/ha) in plots receiving 320 kg N only; it was increased to 9.5 ton/ha by addition of P, to 10.6 ton/ha by addition of 100 kg K, but addition of K to NP fertilizers had no effect. Potassium recovery was highest (61%) in plots with 320 kg N + 100 kg/ha and was depressed by P.

27 Studies on Mineral Ion Absorption by Plants. I. The Absorption and Utilization of Phosphate by *Stylosanthes humilis, Phaseolus atropurpureus*, and *Desmodium intortum*. R. E. White (Dep. Bot., Univ. Witwatersrand, Rep. S. Africa). *Plant Soil 36* (2), 427-47 (1972). *Trop. Abstr. 28*, 376. Pot trials with three legumes grown on a very P-deficient soil enriched with P, conducted in the Rep. of S. Africa over four successive harvests, showed that in the untreated control relative yields of stylo and *P. atropurpureus* were identical and slightly greater than that of *D. intortum*. The relative response to applied P was similar for the three species up to the maximum yield attained.

28 Elephantgrass in the Southeastern Transvaal. L. G. van Zyl. *Farming S. Africa 46* (4), 25, 27, 29, 31 (1970). *Trop. Abstr. 26*, 1739. Elephantgrass is planted on the light soils of the southeastern Transvaal Highveld in double rows 120 cm between and 90 cm in the rows with 360 cm strips between pairs of rows. It is fertilized annually with 159 kg N plus 26.5 kg P/ha and will yield annually 42-53 tons of green material/ha, during a productive life-span of 10 yr. Elephantgrass is considered to be a very suitable silage crop.

TANZANIA

29 Effects of Nitrogen Fertilizer on Natural Pastures in Western Tanzania. B. Walker. *Exp. Agr. 5* (3), 215-22 (1969). *Trop. Abstr. 25*, 873. Field trials on cemented hardpan soils supporting natural pastures, consisting of *Bothriochloa insculpta, Panicum infestum, Hyparrhenia* species, *Cynodon dactylon*, and *Sporobolus pyramidalis*, showed that ammonium sulfate at 375 and 750 kg/ha gave dry matter yields of 590 and 824 kg/ha, respectively. The yield of the control was 277 kg/ha. Crude protein content was 8.6% for the highest N level, as against some 7.5% for lower N and control. With single superphosphate alone at 0, 250, and 500 kg/ha dry matter yields were 716, 784, and 884 kg/ha, whereas combined with 750 kg of ammonium sulfate/ha, yields were 2085, 4607, and 4811 kg/ha, respectively. At high stocking rates cattle weights followed very closely amounts of available dry matter.

UGANDA

30 Effect of Large Applications of Nitrogen Fertilizer on the Productivity and Protein Content of Four Tropical Grasses in Uganda. F. J. Olsen (Makerere Univ., Kampala, Uganda). *Trop. Agr. 49* (3), 251-60 (1972). *Soils Fert. 35*, 5461. In field experiments 0, 224, 448, 896, 1568, or 2240 kg N/ha as $CaNH_4NO_3$ were applied to *Brachiaria ruziziensis, Chloris gayana, Panicum maximum*, and *Setaria sphacelata*. All the grasses responded well to N up to 448 kg/ha but with > 896 kg/ha dry matter yields declined. Dry matter yields and crude protein percentage are given for the grasses at different N levels.

31 The Effect of Phosphate and Lime on the Establishment, Productivity, Nodulation and Persistence of *Desmodium intortum, Medicago sativa*, and *Stylosanthes gracilis*. F. J. Olsen and P. G. Moe (Makarere Univ., Kampala, Uganda). *East Afr. Agr. Forest. J. 37* (1), 29-37 (1971). *FA 5*, 623. A field experiment was conducted to determine the effect of phosphate and lime on the establishment, productivity, nodulation, and persistence of *Desmodium intortum, Medicago sativa*, and *Stylosanthes gracilis*. Phosphate accelerated the rate of establishment of the legumes and significantly increased their dry-matter production. *Desmodium* and *Stylosanthes* produced significantly higher dry matter yields than *Medicago*. Phosphate also increased the nodulation of all the legumes. *Desmodium* and *Stylosanthes* had a significantly higher nodulation rating than *Medicago*. The persistence of *Desmodium* and *Medicago* was enhanced with phosphate. No significant response to liming was shown by either *Desmodium* or *Stylosanthes*. Liming did not affect the establishment, productivity, nodulation, or persistence of these two legumes. Liming did increase the productivity and persistence of *Medicago*.

32 Effects of Fertilizers on Grazed and Cut Elephantgrass Leys at Kawanda Research Station, Uganda. D. Stephens. *East Afr. Agr. Forest. J. 32* (4), 383-92 (1967). *Trop. Abstr. 22*, 2305. Results are presented of a fertilizer experiment on an elephantgrass ley in Uganda. Where the grass was cut and removed, K and Mg fertilizers were required to maintain yields after the first yr. Where the grass was grazed, these two elements were not required and dressing of N and P fertilizers were sufficient to maintain good yields. On grazed grass the response to the higher rate of N was particularly marked after the first yr and its residual effects were large. Nitrogen fertilizers also increased the crude protein content of the grass. Under the experimental conditions the grazing cattle did not noticeably affect the soil moisture regime.

33 Responses of Pasture Species in Eastern Uganda to Phosphorus, Sulphur, and Potassium. W. B. Wendt (Serere Res. Sta. Dep. Agr., Uganda). *East Afr. Agr. Forest. J. 36* (2), 211-19 (1970). *FA 4*, 869. Fertilizer responses of *Hyparrhenia rufa, Panicum maximum, Stylosanthes gracilis, Centrosema pubescens*, and *Macroptilium atropurpureum* were investigated on small ungrazed plots over a 3 yr period. All species responded to P and S to levels of application of about 70 kg/ha of P and 20-40 kg/ha of S, giving yield increases of 40-100%. There was no response to K except by *S. gracilis* in the 2nd yr. Fertilizers were not reapplied in the 3rd yr of the trial, but residual responses of P and S were obtained with most species. Nitrogen fixation by *S. gracilis* was stimulated by P and S, and best treatments yielded 290 kg N/ha/yr in the herbage over a 21 month period, and 1.2 kg/ha/day during a favorable 125 day period.

ZAMBIA

34 Legume/Grass Pastures in Zambia. H. J. van Rensburg. *Farming Zambia 4* (2), 1-4 (1969) (Suppl.) *Trop. Abstr. 24*, 2042. The establishment of legume/grass pastures in Zambia is outlined. Pure stands of *Glycine (Glycine javanica)*, siratro (*Phaseolus atropurpureus*) and stylo (*Stylosanthes guyanensis*) show excellent performance. Grazing potential, fire-, frost-, and drought-tolerance of *Glycine* and siratro are remarkable; resistance to diseases and pests is fair. Productivity is in the order of 6.5 tons dry matter/ha (20% crude protein). Recommendations are: (1) *Glycine* and siratro for loam soils, but siratro and stylo for sands; (2) sowing in existing grass pastures early in the wet season at a rate of 2.1 to 4.2 kg seed/ha; and (3) application of 40-80 kg P_2O_5, 56-112 kg N and 34 kg borate/ha in the lst yr, followed by 20 kg P_2O_5/ha in the 2nd yr, and 20 kg P_2O_5 with 66 kg K_2O/ha in the 3rd yr after sowing.

THE AMERICAS

BRAZIL

35 Exploratory Fertilizer Trial with Five Tropical Legumes on a Savanna Soil. G. E. de Franca and M. M. de Carvalho. *Pesqui. Agropecuar. Brasil. 5*, 147-53 (1970) (Port). *Trop. Abstr. 27*, 140. In Minas Gerais, five legumes were grown in plastic bags filled with a poor acid latosol to which various fertilizer mixtures were added. Liming to a pH of 6 was highly beneficial. Omission of P or minor elements from a complete fertilizer mixture depressed dry-matter production to a degree differing between species and between two varieties of *Glycine javanica*. Omission of K or S had little effect. Nodule weights, amounts of N fixed, and yields of *G. javanica* and *Phaseolus atropurpureus* cultivar Siratro were higher than those of *Pueraria phaseoloides* and *Centrosema pubescens.*

36 The Effect of K Fertilizing on Yield and Nutritive Value of Some Tropical Grasses. A.P.M. Fernandes, J. A. Gomide, and J. M. Braga. *Experientiae 10* (7), 185-208 (1970) (Port). *Trop. Abstr. 26*, 357. Two experiments were carried out in Minas Gerais, to study the effect of K application on yield and nutritive value of *Melinis minutiflora, Panicum maximum, Hyparrhenia rufa,* and *Paspalum notatum*. Potassium was applied at rates of 0, 20, and 40 kg KCl/ha after each harvest together with ammonium sulfate and superphosphate at the rate of 125 kg/ha. A favorable effect on yield and cellulose digestibility could be demonstrated. Field observation also showed a favorable effect on the resistance of the grasses to the attack of *Helminthosporium.*

37 Mineral Composition of Six Tropical Grasses as Influenced by Plant Age and Nitrogen Fertilization. J. A. Gomide *et al* (Purdue Univ. Agr. Exp. Sta., Lafayette, Indiana). *Agron. J. 61* (1), 120-3 (1969). *Biol. Abstr. 50*, 77827. This study was conducted in central Brazil on a sandy loam soil which under normal conditions receives no fertilizer. The K, P, Ca, Mg, Cu, Mn, Fe, and Zn contents were determined in six grasses: *Melinis minutiflora* Beauv., *Digitaria decumbens* Stent., *Pennisetum purpureum* Schum., *Pennisetum clandestinum* Hochst., *Cynodon dactylon* Pers., and *Panicum maximum* Jacq. variety 'Gondlyodes Doell.' Significant decreases in K, P, Mg, Cu, and Fe in the forages ($P<.01$) occurred with advance in plant age from 4 to 36 weeks. The average K content for all grasses at 4 weeks of age was 1.42% and at 36 weeks of age 0.30%. Kikuyugrass had the highest K content at 36 weeks of age (0.54%). The average P content for all grasses was 0.26% at 4 weeks and 0.12% at 36 weeks. Pangolagrass appeared to be a poor source of P at all ages studied (average 0.12%). Nitrogen fertilizer had no effect on any of the minerals studied except for Mn which increased with N fertilization. Under the conditions of the experiment, the forages could be deficient in K and P for cattle and borderline in Zn.

38 Responses of Four Tropical Legumes to P, K and Lime on a Red-Yellow Savanna Latosol. M. B. Jones and L.M.M. de Freitas. *Pesqui. Agropecuar. Brasil. 5*, 91-9 (1970) (Port). *Trop. Abstr. 27*, 141. In Sao Paulo four legumes were grown in pots with a poor acid soil; varying rates of P, Ca, Mg, and K and uniform amounts of S, Zn, and B were applied. Dry-matter production of *Phaseolus atropurpureus* cultivar Siratro and *Glycine javanica* increased with P rates up to 200 kg/ha, that of *Centrosema pubescens* with rates up to 100 kg/ha. Yields of *Stylosanthes gracilis* were much lower, but increased with P rates up to at least 400 kg/ha. Rates of Ca required for maximum yields were 250 kg/ha with *S. gracilis* and 1000 kg/ha with the other 3 species, higher rates resulting in lower yields. Responses to K were small.

39 Responses of Four Tropical Legumes and of Lucerne to Various Levels of Sulfur. M. B. Jones and J. L. Quagliato. *Pesqui. Agropecuar. Brasil. 5*, 359-63 (1970) (Port). *Trop. Abstr. 27*, 142. In Sao Paulo five forage legumes were grown in pots on a poor savanna soil to which a fertilizer mixture without N or S had been applied; H_2SO_4 was added at 6 rates supplying up to 60 kg S/ha. Lucerne yields showed a higher response to S than those of four tropical species; the five legumes differed with respect to the growing period in which they profited most from the added S. Concentrations of S and N in the plants increased with increasing S rates; those of S decreased as the plants became older. Sulfate ion concentrations in leaves of *Stylosanthes gracilis* and *Centrosema pubescens* were higher than those in leaves of *Glycine javanica, Phaseolus atropurpureus*, or lucerne.

40 Responses of Lucerne and Some Tropical Legumes to Applications of Mineral Nutrients on Three Savanna Soils. M. B. Jones, J. Quagliato, and L.M.M. de Freitas. *Pesqui. Agropecuar. Brasil. 5*, 209-14 (1970) (Port). *Trop. Abstr. 27*, 144. In Sao Paulo a pot trial with lucerne and seven tropical legumes grown on a poor acid latosol showed very poor development unless lime and minor elements were applied; application of K and N had little effect, reactions to P and S differed between species. Specific differences were also seen in the N contents of the plants. In a trial with four species on a regosol, application of Cu and Fe depressed the growth; *Stylosanthes gracilis* reacted positively to B, *Glycine javanica*

to B and Zn. The growth of *G. javanica* was also promoted by Zn when it was grown on a yellow latosol but not on the red latosol of the first trial.

41 Economic Analysis of Experiments with Feedstuffs and Cattle Conducted in the State of Sao Paulo. S. F. Miller, L. R. Quinn, and G. O. Mott. *Pesqui. Agropecuar. Brasil. 5*, 101-16 (1970) (Port). *Trop. Abstr. 27*, 130. A series of experiments conducted during 1961-65 in the State of Sao Paulo is reviewed from an economic standpoint. Grazing of zebu cattle on pangola (*Digitaria decumbens*) pasture was more profitable than grazing on five other grasses when soil fertility was mediocre: *Panicum maximum* came second and is probably better on more fertile soils. Application of 100 kg N/ha annually to *P. maximum* pastures was profitable, as were supplementary feeding with molasses and the use of stilbestrol. Supplementary feeding with maize meal or other low-protein meals may be profitable when the available pasture is of poor quality.

42 Comparison of Varieties and Hybrids of Elephantgrass, *Pennisetum purpureum*, for the Establishment of Fields of this Grass on Savanna Soils. O. L. Mozzer, M. M. de Carvalho, and E. S. Emrich. *Pesqui. Agropecuar. Brasil. 5*, 395-403 (1970) (Port). *Trop. Abstr. 27*, 132. Twelve cultivars of elephantgrass were compared on a red-yellow latosolic savanna soil in the State of Minas Gerais. The trial field received 5 tons of lime/ha and fertilizers providing N, P, K, and Zn. The best variety was Mineiro which over a 2-yr period (three cuttings) produced 129 tons/ha of green forage containing 28.9 tons of dry matter and 2.15 tons of protein. All other cultivars yielded considerably less; the least productive one produced only 11 tons of green forage/ha.

43 Comparison of 10 Fodder Grasses on a Savanna Soil in 1965. R.M.A. Pereira *et al. Rev. Ceres 13* (74), 141-53 (1966) (Port). *Trop. Abstr. 22*, 311. A trial to compare 10 fodder grasses was established in the State of Minas Gerais in Nov. 1964. Total fresh-matter yields up to Dec. 1965 of five elephantgrass varieties were, in tons/ha: Napier and Mercker 260, P.R. 534, 221, Mineiro 215, Puerto Rico 200; yields of other species were: *Setaria sphacelata* 106, guatemalagrass 99, guineagrass 79, *Ixophorus unisetus* 34, and *Axonopus scoparius* 22 tons/ha. The order of productivity in the wet and dry seasons was about the same. Fertilizers caused an average increase of 12% in the wet season. In the dry winter months, fertilizers alone had no effect, irrigation was highly beneficial, and there was a considerable positive fertilizer x irrigation interaction.

44 Manganese Toxicity in Tropical Forage Legumes. S. M. Souto and J. Dobereiner. *Pesqui. Agropecuar. Brasil. 4*, 129-38 (1969) (Port). *Trop. Abstr. 26*, 1233. In the first of two pot experiments conducted in Brazil, the effect of four levels of Mn-sulfate (0, 50, 100, and 200 ppm Mn/pot) on six legumes were studied. At 0 ppm, *Centrosema pubescens, Pueraria javanica* and *Phaseolus atropurpureus* showed the best growth. From 50 to 200 ppm, growth and percentage of plants with *Rhizobium* nodules decreased; *C. pubescens* was the most tolerant. In the second experiment lime + superphosphate had a favorable effect on nodulation and plant growth of *Glycine javanica* grown on two Mn-toxic soils; the effect of lime alone was not as good, indicating P deficiency in these soils.

45 A Study of the Time of Nitrogen Application to Guineagrass (*P. maximum*) for the Production Increase of Forage for the Dry Season. J. C. Werner (Sec. Agron. Plantas Forrageiras, Div. Nutr. Animal Pastagens, Brazil). *Bol. Ind. Anim. 27* (8), 361-7 (1970-71) (Port). *Trop. Abstr. 28*, 901. Three yr of field experiments conducted in Sao Paulo State with N application at different times of the yr showed that the best time for N application with respect to dry season forage production is at the end of the rainy season. Applications during the rainy season enhance the production during this season but not the dry season production. A split application twice/yr increased neither the total annual forage production nor the dry season forage production.

46 The Comparison of Different Phorphorus-Fertilizers. J. C. Werner *et al. Bol. Ind. Anim. 25* (1), 139-49 (1968) (Port). *Trop. Abstr. 25*, 1382. The effect of several P fertilizers on the production of pangolagrass was studied for 3 yr in the State of Sao Paulo. It was concluded that for pasture fertilizing a mixture of ready-soluble P fertilizer with a slowly soluble and less expensive rock phosphate is to be recommended. This treatment should be repeated every 3-4 yr.

47 The Effect of Liming on the Effectiveness of Phosphate Fertilizing with Rock Phosphate and Superphosphate of Pangolagrass. J. C. Werner *et al. Bol. Ind. Anim. 24* (1), 169-73 (1967) (Port). *Trop. Abstr. 25*, 1114. Liming and P fertilizing of pangolagrass growing in the State of Sao Paulo, on a slightly acid soil of medium P content, had no effect on the yield of the grass. It is concluded that the results confirm the opinion that this grass grows better on slightly acid soils, and that a moderate P level of the soil is sufficient.

48 The Effects of Nitrogen Fertilizers on the Forage Production. J. C. Werner *et al. Bol. Ind. Anim. 25* (1), 151-9 (1968) (Port). *Trop. Abstr. 25*, 1381. Nitrogen-fertilizing of pangolagrass (*Digitaria decumbens*) pasture in the State of Sao Paulo gave highly significant yield increases. Of plots fertilized at rates of 0, 75, and 150 kg N/ha, dry matter yields were 17,650, 24,420, and 27,940 kg/ha, and the protein yields 1002, 1649, and 2048 kg/ha, respectively. No difference was observed between treatments with different N-fertilizers.

49 Studies of Split Application and Different Levels of Nitrogen Fertilizers on Pangolagrass (*Digitaria decumbens* Stent.). J. C. Werner *et al. Bol. Ind. Anim. 24* (1), 147-54 (1967) (Port). *Trop. Abstr. 25*, 1115. Experiments with split applications and different levels of N fertilizers on pangolagrass in the State of Sao Paulo showed that the dry matter production increased in proportion to the higher levels of fertilizer. The same occurred with the protein content and the protein production/ha. The application of N twice/yr was better than once/yr.

BRITISH HONDURAS

50 Fertilizer Response with Pangolagrass on Puletan Loamy Fine Sand, British Honduras, as Indicated by Pot Experiments. W. G. Blue. *Trop. Agr. (Trinidad) 46* (1), 25-9 (1969). *Trop. Abstr. 24*, 1559. In pot experiments, conducted in Br. Honduras, pangolagrass (*Digitaria decumbens*) growing on Puletan loamy fine sand yielded 13-fold by application of P in presence of sufficient other nutrients. The P content of the forage increased with increasing rates of applied P, but not proportionally to yields. The maximum yield was obtained when P was applied at 64 ppm. Forage P concentrations were probably deficient for cattle at all but the highest P

application rate (220 ppm). The response to lime was linear but might have depended on the applied P levels. Yield response to N was also substantial when P was applied, whereas there was no response to K, Mg, and S on this virgin soil.

COLOMBIA

51 Cutting Frequency of and Application of Nitrogen to Four Grasses for Hot Climates. A. Bastidas R. *et al. Agr. Trop. 23* (11), 747-56 (1967) (Span). *Trop. Abstr. 23*, 997. In a trial with four fodder grasses, conducted in Colombia on an irrigated field at an altitude of 378 m during 4 yr, K and P fertilizers were applied uniformly whereas up to 200 kg N/ha was applied every 6 weeks. Two tall grasses: napiergrass (*Pennisetum purpureum*) and guineagrass (*Panicum maximum*) showed yields increasing considerably with N rates up to 200 kg/ha; the short grass *Hyparrhenia rufa* showed maximum yields at 100 kg N/ha, whereas dwarf guineagrass was intermediate in this respect. On the basis of yield increases/kg N, 50 kg N/ha/6 weeks is recommended for the two tall grasses, 25 kg N/ha for the shorter grasses. Cutting intervals of 6 and 9 weeks were better than a 3-week interval.

52 Levels and Frequencies of Application of Nitrogen to Pangolagrass. H. Cortes Padilla. *Acta Agron. (Palmira) 16* (3-4), 101-31 (1966) (Span). *Trop. Abstr. 22*, 2082. Plots of pangolagrass at Palmira received 100 kg P_2O_5 + 50 kg K_2O/ha after every third harvest, and up to 200 kg N/ha/cutting interval applied after 1, 2, or 3 successive harvests. The grass was cut when it attained a height of 40-50 cm in the plots with the highest rate of N. Total dry forage and protein yields of six consecutive harvests increased about linearly with the amount of N applied. Application of N fertilizer after each harvest resulted in higher total yields than did less frequent applications when 100 or more kg N/ha/cutting interval was applied in lower yields when smaller rates were given.

53 Application of Nitrogen and Irrigation to Kikuyugrass (*Pennisetum clandestinum*). V. Davila S. and S. Echeverri E. *Agr. Trop. 23* (11), 744-6 (1967) (Span). *Trop. Abstr. 23*, 998. *Pennisetum clandestinum*, being resistant to drought and thriving on a wide variety of soils, is an excellent forage grass for the Colombian highlands. In an irrigated pasture of this grass situated at an altitude of 2640 m containing 40% of a white clover initially and well supplied with P and K fertilizers, dry matter yields were not increased by ammonium sulfate applied at a rate of 25 kg N/ha after each harvest or at equivalent rates after each 2nd, 3rd, or 4th harvest; they were increased by higher rates of N (up to 300 kg/ha/harvest), application after each harvest being best. The proportion of clover was not reduced by the lowest rate of N except when applied after each fourth harvest, and was progressively reduced by higher rates of N.

54 Doses and Frequency of Nitrogen Application to Three Tropical Grasses. L. Escobar R. *et al. Agr. Trop. 23* (11), 726-37 (1967) (Span). *Trop. Abstr. 23*, 1001. In trials with three fodder grasses in a lowland region of Colombia, urea at rates of up to 1200 kg N/ha/6 harvests was applied after each cutting, after each 2nd cutting, or after each 3rd cutting. Phosphorus and K were applied annually. With increasing amounts of N, dry matter yields increased considerably; protein percentages generally increased but were depressed in a few cases by high fertilizer rates. On the basis of yields and their seasonal distribution, 100 kg N/ha after each harvest appeared to be best for *Panicum maximum* and *Digitaria decumbens* cut as soon as they became 1.3 and 0.4 m high, respectively; 150 kg N/ha was best for *Brachiaria purpurascens* cut at a height of 0.7 m.

55 Rates and Frequency of N Application to Coastal Bermudagrass. L. Escobar R., A. Ramirez P., and J. Lotero C. (Centro Nac. Invest. Agropec. Turipana, Colombia). *Rev. Inst. Colomb. Agropecuar. 4* (4), 269-76 (1969) (Span). *FA 4*, 1033. In a plot test in 1965-67 at Turipana (20 m altitude, 28° average temperature, 1112 mm average annual rainfall), N was applied to coastal bermudagrass at 0, 25, 50, 75, and 100 kg/ha after each cut; 0, 50, 100, 150, and 200 kg/ha after alternate cuts; or 0, 75, 150, 225, and 300 kg/ha after every three cuts. Results were examined after each of two cycles of six cuts. The results were: within each frequency of application, yields of herbage dry matter increased with increasing rates of N; in general, herbage yields were higher when N was applied after each cut. Yields in the second cycle were lower than in the first. Yields of herbage dry matter/kg applied N decreased with increasing rates of N and with longer intervals of application. It was estimated that with 25-50 kg N/ha applied after each cut or grazing, the stocking rate would be 4-5 animals (weighing 350 kg each)/ha.

56 Effect of Nitrogen Applied to Soil and Foliage on Yield and Protein Content of Pangolagrass (*Digitaria decumbens*). A. Grisales G. and A. Uribe H. *Cenicafe 17* (4), 132-41 (1966) (Span). *Trop. Abstr. 22*, 2509. In Colombia, plots of pangolagrass cut at 2-month invervals received urea applications either to the soil immediately after each harvest or to the foliage 30 and 45 days after cutting. Yields increased with increasing rates of N (100, 200, and 300 kg/ha/yr) but for any N level were lower in the sprayed plots. Protein contents were higher in the sprayed plots and in sprayed plots increased with the N doses, but protein yields in the sprayed plots remained lower than when urea was applied to the soil. The highest urea concentrations tested, 5.4% in the first sprayings and 10.8% in the second sprayings, were well tolerated.

57 Effect of Nitrogen and Frequency of Application on the Yield of Forage and Protein of Pangolagrass. G. Herrera P., J. Lotero C., and L. Crowder. *Agr. Trop. 23* (5), 297-312 (1967) (Span). *Trop. Abstr. 22*, 2083. In Colombia, plots of pangolagrass (*Digitaria decumbens*) at an altitude of 1450 m, receiving supplementary irrigation, were cut at 6-week intervals. Nutrients applied were 100 kg P_2O_5 + 100 kg K_2O/ha after every six cuts, N (as urea) at up to 400 kg/ha/cutting interval in 1, 2, or 3 applications. Yields increased with the N rate but over 100 kg/ha/6 weeks was not profitable. Differences between frequencies of N application were rather small. High N rates resulted in scorching and in invasion by *Cynodon dactylon* and *Cyperus* species. Continuous application of urea lowered the soil pH and reduced soil fertility.

58 Planting Distance and Nitrogen Application in Elephantgrass. J. Lotero C. *et al. Rev. Inst. Colomb. Agropecuar. 2* (2), 123-33 (1967) (Span). *Trop. Abstr. 23*, 1218. In a trial with elephantgrass, conducted in Colombia at an altitude of 1435 m during 5 yr, the grass was cut 21 times when it started to flower. Mean dry-matter yields of the main treatments, in tons/ha/cutting, were: continuous rows of stems planted 75 cm apart 10.56; slanting stem pieces planted at 0.5 x 0.5, 1 x 1, and 2 x 2 m, respectively, 9.42, 8.36, and 9.11. Subtreatments were applications of 0, 50, 100, and 200 kg N/ha after

each cutting (with uniform application of P and K fertilizers); they resulted in mean yields of 7.19, 8.56, 10.45, and 11.25 tons of dry matter/ha/cutting, respectively. The protein content was slightly increased by N fertilizer both in the wet and in the dry seasons.

59 Planting Distances and Rates of Nitrogen in *Axonopus scoparius* Pasture. J. Lotero C. *et al. Rev. Inst. Colomb. Agropecuar. 4* (3), 147-57 (1969) (Span). *Trop. Abstr. 25*, 2679. Planting and fertilizing experiments with *Axonopus scoparius* were carried out in Medellin, Colombia, at 1425 m altitude and an annual rainfall of 1340 mm. Spacings of the grass varied from 50 x 50 cm to 150 x 150 cm. The highest yields were obtained with a spacing of 50 x 50 cm, although the differences with spacings of 50 x 100 and 100 x 100 cm were insignificant. A spacing of 150 x 150 cm resulted in the lowest yields. The grass received a basic NPK treatment and additional fertilizing with N at 0, 50, or 100 kg/ha after each cutting. Additional N at 100 kg/ha slightly increased the protein content of the grass from 4.03% to 4.21%, and the mean dry forage yield/cutting increased from an average 7.58 kg/ha to 11.48 kg/ha.

60 Sources, Rates, and Methods of Nitrogen Application to Elephantgrass. J. Lotero C., A. Ramirez P., and G. Herrera P. (Centro Nac. Invest. Agr. Tulio Ospina, Medellin, Colombia). *Rev. Inst. Colomb. Agropecuar. 3* (2), 113-21 (1968) (Span). *FA 4*, 1031. In a plot test in 1961-66 at Medellin (1425 m altitude, 1340 mm average annual rainfall, 21° average temperature) elephantgrass was established from cuttings and given 50 or 150 kg N/ha after each cut. Phosphorus and K were also applied. The stand was cut when it had reached a height of 1.50 m; a total of 19 cuts were taken. The rate of 150 kg N/ha gave highly significant increases in herbage yield compared with the 50-kg rate. The percentage of protein in the herbage was higher in the wet than in the dry season and was increased by N application. There were no differences in yield resulting from methods of N application (broadcasting, placing around the base of the plant, or band application).

61 Cutting Frequency of and Application of Nitrogen to Angletongrass. A. Michielin *et al. Agr. Trop. 23* (11), 714-20 (1967) (Span). *Trop. Abstr. 23*, 989. *Dichanthium aristatum (= Andropogon nodosus)*, introduced into Colombia in 1956, has become a popular pasture grass for altitudes up to 1200 m. A trial with this grass, conducted at an altitude of 1000 m in 1962-66, compared cutting intervals of 3, 6, and 9 weeks and urea applications after each cutting at rates of up to 600 kg/ha/18-week experimental cycle; P and K fertilizer were applied uniformly over the whole trial field. Dry-matter yields and concentrations of nutrients and minerals were determined. They confirmed that the grass responds well to N fertilizer. The best treatment appeared to be a cutting interval of 6 weeks with applications of 25-50 kg N after each harvest and of adequate amounts of P and K.

62 Interplot Movement of Fertilizer in Pangolagrass (*Digitaria decumbens*) Pasture. J. Parra H. *Cenicafe 19* (3), 102-12 (1968) (Span). *Trop. Abstr. 25*, 1904. A NPK-fertilizer trial was conducted in Colombia on pangolagrass (*Digitaria decumbens*) pasture mainly to assess the possible effect of interplot nutrient movement. The results indicated, among others, that: (1) the productivity of the plots was directly related to rainfall, (2) plots separated by ditches were less productive due to the high permeability of the volcanic soil; (3) N and P fertilizers, alone or in combination, were most effective; and (4) growth tended to decrease with successive cuts.

63 Effect of Application of Nitrogen Fertilizer to Pangolagrass (*Digitaria decumbens*). A. Uribe H. and A. Grisales G. *Cenicafe 17* (3), 99-107 (1966) (Span). *Trop. Abstr. 22*, 2508. Plots of uniform trials with pangolagrass, conducted in three Colombian departments during 27 months, received ammonium sulfate at rates of up to 80 kg N/ha after each of the five cuttings taken annually. After some time decreasing yields made additional application of P and K fertilizers necessary. Average yields of plots without N fertilizer were 8.9, 12.4, and 16.0 tons of dry forage/ha/yr, respectively. They increased almost linearly with the rate of N, the maximum rates resulting in yield increases of 110, 105, and 83%, respectively. Protein content in one trial was around 7% irrespective of the N rate, in another trial increased from 6.60 to 7.66% with increasing rates of N.

64 Response of Pangolagrass to Different Sources and Dosages of Nitrogen. F. Villamizar R. and J. Lotero C. *Rev. Inst. Colomb. Agropecuar. 2* (1), 57-70 (1967) (Span). *Trop. Abstr. 23*, 1211. A nitrogen fertilizer trial with *Digitaria decumbens* was conducted in Colombia at an altitude of 1485 m during 5 yr; P and K fertilizers were applied uniformly. Yields of dry matter and protein increased with N rates of up to 200 kg/ha applied after each of the 25 cuttings; rates over 100 kg/ha were less efficient than lower rates. Application of Chilean nitrate, ammonium sulfate, and urea gave average yields of 5.74, 5.00, and 4.84 tons of dry matter and of 476, 460, and 407 kg crude protein/ha/cutting, mean protein contents of 8.3, 9.2, and 8.4%, and final soil pH values of 6.7, 4.5, and 5.6, respectively. The initial pH of the sandy loam soil was 5.8.

COSTA RICA

65 Fertilization of Elephantgrass (*Pennisetum purpureum*) in Turrialba, Costa Rica. I. Effect of Increasing Nitrogen Doses. Ricardo Guerrero, H. W. Fassbender, and John Blydenstein (Univ. Narino, Pasto, Colombia). *Turrialba 20* (1), 53-8 (1970) (Span). *FA 4*, 687. Elephantgrass was fertilized with 0, 200, 400, and 600 kg N/ha (urea) in three applications. Nitrogen at 600 kg/ha tripled production of dry matter. All applications of N increased the protein content of the grass, but diminished the P content. Calcium and fiber were not affected. Production of dry matter was directly related to the rainfall; best response to N fertilization was in periods of high rain. Time of harvest caused significant differences in all variables.

66 Fertilization of Elephantgrass (*Pennisetum purpureum*) in Turrialba, Costa Rica. II. Effect of Phosphorus Nitrogen Compositions. Ricardo Guerrero and H. W. Fassbender (Univ. Narino, Pasto, Colombia). *Turrialba 20* (1), 59-63 (1970) (Span). *FA 4*, 688. Elephantgrass was fertilized with 200 and 400 kg N/ha (urea) and 100 and 200 kg P_2O_5/ha (triple superphosphate). Nitrogen was primarily responsible for an increase in dry matter, protein, and Ca, and a reduction in P. Triple superphosphate increased P content. Harvest time and season of rainfall caused significant differences in dry matter yields and all other variables.

67 Effects of Lime and Phosphorus on Selected Alluvial Entisols from Eastern Costa Rica. II. Forage Plant Responses.

L. N. Lucas and W. G. Blue (Inst. Food Agr. Sci. Univ. Florida, Gainesville). *Trop. Agr. (Trinidad) 50* (1), 63-74 (1973) (Eng). *CA 78*, 96525. A glasshouse study was conducted on the effects of lime on native soil P availability. The availability of applied P was measured by pangolagrass (*Digitaria decumbens*). The grass, grown in surface soils and subsoils that had large amounts of residual P of low availability, responded markedly to applied P. The amounts of applied P necessary for maximum yields were 290 ppm for the limed and 348 ppm for the unlimed soils. In untreated surface soils, forage growth improved as the grass developed more extensive root systems, but remained very poor in the subsoil where P was omitted. Applied P enhanced root growth for 1 yr. Forage P concentrations were low (0.03 to 0.12%), even at high rates of applied P. Recovery of applied P in the forage varied from 3.4 to 14% dependent on liming and P rates. Forage yields decreased as lime rates were increased, regardless of the rate of P applied. Lime affected root growth adversely. Soil pH increased from 5.1 to 6.6 after application of 75 ppm of P and 5000 ppm $CaCO_3$.

68 Pangolagrass (*Digitaria decumbens* Stent.) Growth as Affected by Organic Materials and Calcium Silicate Applied to a Soil from Los Diamantes, Costa Rica. L. N. Lucas and W. G. Blue (Univ. Florida, Gainesville). *Trop. Agr. 29* (4), 281-6 (1972). *FA 6*, 491. The effect of organic materials and Si on pangolagrass growth and P contents in a soil from Los Diamantes, Costa Rica, was studied in a greenhouse experiment. There was an immediate, but temporary, beneficial effect on plant growth of Si and plant residues added to the soil. Calcium silicate, rice hulls, and *Stylosanthes humilis* increased forage yields, but these increases were significantly higher than the control only at the first harvest. Forage P concentrations were increased by Ca silicate, rice hull, and *S. humilis* treatments. The higher forage P concentrations may have been due to the increased availability of soil P or, in the case of plant residues, to increased available P from their decomposition. Large amounts of soluble sugar added to the soil reduced forage yields markedly, possibly because of N and P immobilization. Incorporation of rice hulls, where they are abundant, into tropical soils deficient in available P, probably is a desirable practice, particularly for small, intensively managed plantings.

69 Nitrogen and Phosphorus in Jaraguagrass During the Dry Season in a Tropical Savanna as Affected by Nitrogen Fertilization. L. E. Tergas and W. G. Blue (Univ. Florida, Gainesville). *Agron. J. 63* (1), 6-9 (1971). *FA 4*, 716. The effect of N fertilization during the latter part of the rainy season on yield and N and P composition of jaraguagrass [*Hyparrhenia rufa* (Nees) Stapf] and during the Dec.-May dry season in the wet-dry Guanacaste Province of Costa Rica, was studied. Forage production increased with N fertilization through January 13 and decreased erratically as the plants dried. Forage N concentrations and contents were increased by N fertilization, but decreased after the initial harvest on November 30 as the dry season progressed. Forage P concentrations and contents also decreased. Root N concentrations and contents generally increased as forage N decreased with time into the dry season. Forage regrowth during the subsequent rainy season was higher when the dry season harvest was delayed. Apparently these elements were lost from the forage by translocation to the roots. The beneficial effect of N fertilizer on forage quality persisted only for a relatively short time after initiation of the dry season.

CUBA

70 Trials with Five Populations of *Clitoria ternatea* L. E. de Matos and R. de la Torre. *Rev. Cubana Ciencia Agricola 4* (3), 217-21 (1970) (Span). *Trop. Abstr. 26*, 2559. Wild growing *Clitoria ternatea* in eastern Cuba has been used for fodder many yr, and the legume is considered a promising forage crop. Three Mexican varieties and two Cuban ecotypes were comp[illegible] in the central part of the island; all trial plots receiv[illegible] fertilizers at the rate of 30 tons sugar-mill filter cake plus 23 kg N, 92 kg P, and 92 kg K/ha. A Mexican variety produced 81.8 tons of fresh forage/ha in 12 months without irrigation, 84.0 tons/ha when sprinkler-irrigated with 25 mm water every 9 days. The four remaining types produced significantly less but responded better to irrigation. Yields of all the types in the dry season dropped to zero without, and to a very low level with irrigation.

71 The Effect of Inoculation and Foliar Urea on Kudzu (*Pueraria phaseoloides*) and Pigeon Pea (*Cajanus cajan*). G. Febles and C. Padilla (Inst. Ciencia Anim., San Jose de las Lajas, Habana, Cuba). *Rev. Cubana Ciencia Agricola 4* (2), 149-51 (1970) (Eng). *FA 5*, 1176. In a trial on clay soil, seed of *Pueraria phaseoloides* and *Cajanus cajan* was inoculated with *Rhizobium* before sowing. Urea was sprayed at a rate of 26 kg N/ha at each of three applications between cuts. *Pueraria phaseoloides* yielded 66% more dry matter (19.7 ton/ha) from five cuts in a yr than *C. cajan* (11.9 ton), but there was no effect from inoculation or foliar-urea application. In two of the three cuts of *P. phaseoloides*, urea increased the protein content by 15%. It was concluded that *P. phaseoloides* is a potential source of forage during the wet season.

72 Effect of Cutting Interval and Nitrogen Fertilizer on the Productivity of Eight Grasses. F. Perez Infante. *Rev. Cubana Ciencia Agricola 4* (2), 137-48 (1970). *Trop. Abstr. 26*, 1730. In Cuba, four cultivated grasses, *Digitaria decumbens, Brachiaria mutica, Hyparrhenia rufa* and *Panicum maximum*, and four noncultivated ones, *Andropogon annulatus, A. pertusus, A. caricosus* and *Paspalum notatum*, were fertilized with N at 0, 200, and 400 kg/ha/yr, and cut at 36, 45, and 60 day intervals. The mean annual yields of the cultivated grasses in tons of dry matter/ha were: *B. mutica*, 21; *P. maximum*, 19; *D. decumbens*, 17; and *H. rufa*, 15; the respective contributions during the dry season were 42, 44, 33, and 44%. The corresponding data for the noncultivated grasses were: *A. annulatus*, 17; *A. pertusus*, 15; *A. caricosus*, 15, and *P. notatum*, 14; and in the dry season 46, 40, 40, and 19%.

73 The Influence of Nitrogen Fertilization on the Yield of a Pangola Pasture. H. Wollner. *Beitr. Trop. Subtrop. Landwirt. Tropenveterinarmed. 6* (1), 27-31 (1968) (Span). *Trop. Abstr. 24*, 846. In Cuba a N fertilizer trial, which is still in progress, has shown so far that the most suitable amount of N fertilizer for a pangola pasture depends each season on the water supply. The more water can be supplied the more N can be applied, which results in higher yields and protein contents. Neither water nor N fertilizer stimulates the growth of the pasture plants in the dry, cold winter.

GUYANA

74 Fertilizer Studies with Pangolagrass (*Digitaria decumbens* Stent.) on Tiwiwid Fine Sand in Guyana. I. Effect

of Fertilizer Nitrogen, Phosphorus, and Potassium on Dry Matter Production. H.A.D. Chesney (Min. Agr. Sub-Sta., Long Creek, Guyana). *Agr. Res., Guyana 3,* 131-5 (1969). *FA 4,* 1813. Tiwiwid fine sand occupies 69,000 acres of 137,000 acres of previously unexploited land opened up by new road construction in the Demerara river hinterland (average annual rainfall 2500 mm). Pangolagrass planted in December 1968 at 2 x 2 ft square on land newly cleared from forest was given a basal dressing of 1100 kg dolomitic limestone/ha, and applications every 3 months after planting of kieserite, micronutrients, and all combinations of 0, 55, or 110 kg N; 0, 33, or 66 kg P_2O_5; and 0, 33, or 66 kg K_2O/ha, and was cut at intervals of 6 weeks from early March to late November 1969. Total herbage dry matter (DM) production was not affected by N, but was increased from 7650 kg/ha in plots given no P to 11,133 and 11,632 kg by 33 and 66 kg P_2O_5/ha, respectively. Potassium progressively increased DM yields from 7118 kg/ha in plots given no K to 12,544 kg in plots given 66 kg K_2O/ha. The second cut after each fertilizer application yielded less than the first cut after application.

75 Fertilizer Studies with Pangolagrass (*Digitaria decumbens* Stent.) on Tiwiwid Fine Sand, Guyana. II. Effect of Magnesium and Trace Elements on Dry Matter Production. H.A.D. Chesney (Min. Agr. Sub-Sta., Long Creek, Guyana). *Agr. Res., Guyana 3,* 136-8 (1969). *FA 4,* 1956. In a trial on Tiwiwid fine sand in 1968-69, Pangolagrass was given a basal dressing of 1100 kg dolomitic limestone/ha at planting in December 1968, followed by applications every 3 months of 55 kg N + 33 kg K_2O + 33 kg P_2O_5 and all combinations of 0, 22, or 44 kg MgO/ha and 0, 22, or 44 kg FTE 503 (fritted B, Cu, Fe, Mn, Mo, and Zn)/ha, and was cut at intervals of 6 weeks from the end of March to early December 1969. Total herbage dry matter production was not affected by Mg, but was increased from 6054 kg/ha in plots given no micronutrients to 11,957 kg/ha by 22 kg FTE/ha. Application of 44 kg FTE/ha gave a slightly lower yield (10,645 kg/ha).

76 Response of *Digitaria setivalva* to Nitrogen, Phosphorus, Potassium, Magnesium and Calcium on Ebini Sandy Loam, Guyana. I. Effect on Yield, Tissue Composition and Nutrient Uptake. H.A.D. Chesney (Min. Agr. Nat. Res., Georgetown, Guyana). *Trop. Agr. 49* (2), 115-24 (1972). *Soils Fert. 35,* 3531. In a 2^5 factorial experiment N (0 or 83 kg/ha) as $(NH_4)_2SO_4$, P (0 or 50 kg/ha) as triple superphosphate, K (0 or 52 kg/ha) as KCl, Mg (0 or 7 kg/ha) as kieserite and Ca (0 or 1120 kg/ha) as calcitic limestone were applied to plots of *Digitaria*. The soil had low contents of N, P, K, Mg, and Ca. Dry matter production increased by 8000 and 4000 kg/ha with application of N and P respectively. Calcium, K, and Mg did not affect yield. Although N, P, and K applications increased the tissue contents of these nutrients, the percentage recoveries of fertilizer N, P, and K were low.

77 Yield Response of Pangolagrass Grown on Tiwiwid Fine Sand to Mg and Fritted Micronutrients. H.A.D. Chesney (Cent. Agr. Sta., Mon Repos, East Coast Demerara, Guyana). *Agron. J. 64* (2), 152-4 (1972). *Soils Fert. 35,* 3532. The soil was an excessively drained, coarse textured (>98% sand) regosol of very low fertility. After liming and NPK fertilizing, Mg and fritted micronutrients (containing 3.83% B, 2.97% Cu, 17.98% Fe, 7.36% Mn, 0.26% Mo, and 7.03% Zn) were applied at two rates up to 176 kg/ha/yr before planting with pangolagrass (*Digitaria decumbens*). The yield response to Mg and the Mg x micronutrient interaction were not significant. Micronutrient treatment prevented plant deficiency symptoms and, at 88 kg/ha/yr, generally, and 176 kg/ha/yr during periods of heavy rainfall, about doubled yields over 18 months (the effect being greater with time).

HAITI

78 A Note on Angletongrass, *Dichanthium aristatum*. F. Maignan and R. Laurin. *Rev. Elevage Med. Vet. Pays Trop. 20* (3), 485-91 (1967) (Fr). *Trop. Abstr. 23,* 1527. The Asiatic grass *Dichanthium aristatum* has become widespread in Haiti along roadsides, in pastures, and as a weed. It is grown as a valuable fodder species by sowing broadcast or in furrows 0.5-1 m apart, using 15-25 and 7-15 kg of seed/ha, respectively. In a small-scale trial, dry-matter yields/ha over 40 weeks were: without fertilizer 14.6 and 10.0 tons/ha at cutting intervals of 4 and 6 weeks, respectively; with 500 kg ammonium sulfate/ha, 26.7 and 17.1 tons at cutting intervals of 4 and 6 weeks, respectively. The protein content at the age of 4 weeks was 8.9%.

JAMAICA

79 Research Enterprises. II. Pasture Research. L. E. McLaren. *Bodles Anim. Prod. Res. Sta. Bull., 1* 10-13 (1968). *Trop. Abstr. 24,* 374. In Jamaica, comparative productivity trials were conducted with 3 irrigated grasses as affected by cutting heights of 2.5, 5, and 7.5 cm, at intervals of 1, 3, 6, and 9 weeks, and at fertilizer levels of 0, 1, 2, and 4 tons of ammonium sulfate/ha. Dry matter yields ranged from 8 to 48 tons/ha/yr; *Cynodon dactylon* and *Digitaria decumbens* showing favorable responses to severe cutting heights. *Panicum maximum* outyielded the other two species at all fertilizer levels; however, this species was less persistent and produced less dry matter with the most extreme cutting height. Other studies reported deal with: meat and milk production trials with irrigated and fertilized *P. maximum;* grazing patterns of heavily fertilized and irrigated *D. decumbens;* introduction trials with 41 cultivars of various forage plants; and fattening trials.

80 Preliminary Studies on the Nutrient Requirements of Pangolagrass on Bauxite Soils in Jamaica. Hugh Payne *et al* (Antilles Chem. Co., Jamaica). *Antilles Chem. Co., Jamaica Res. Bull. No. 1, 1969 and 1970,* 58-84 (1970). *FA 5,* 1046. Two fertilizer microplot trials were carried out during the period 1968-70 in order to determine the major factors contributing to reduced pasture productivity on brown and red bauxite soils. A latin square design involving seven fertilizer treatments was used to evaluate the influence of N, P, K, Mg, and micronutrients on yield of pangolagrass. On both soil types, K was found to be the chief nutrient limiting yields. The application of N alone apparently created a nutrient imbalance which contributed to a progressive reduction in pasture productivity with time. There was some evidence that application of P could be beneficial on red bauxite soils, but might actually be associated with reduced yields on brown bauxite soils. There was no apparent benefit from the application of Mg or micronutrients. The relationship between pasture productivity and rainfall patterns was demonstrated.

MEXICO

81 Meat Production on Fertilized Pangola and Jaragua

Grasses in the Tropical Aw Climate. R. Garza T., D. Arroyo, A. Perez S. *Tecn. Pecuaria Mexico 14,* 20-4 (1970) (Span). *Trop. Abstr. 26*, 2553. In Veracruz, 2-year-old crossbred zebu steers with an initial weight of 250 kg were grazed on plots of *Digitaria decumbens* (pangolagrass) and *Hyparrhenia rufa* (jaraguagrass) during the rainy seasons (July-Jan.) of 1966 and 1967. Half of each plot received 50 kg N/ha in July and an equal amount in Sept. Daily weight gains, meat production/ha, and carrying capacity were higher in pangolagrass plots than in jaraguagrass plots; they were increased by the N fertilizer dressings on both grass species, but the response of jaraguagrass to the fertilizer was too small to cover the cost.

PUERTO RICO

82 Effect of Nitrogen Rates, Harvest Interval, and Cutting Heights on Yield and Composition of Stargrass in Puerto Rico. R. Caro-Costas, F. Abruna, and J. Figarella (Agr. Exp. Sta., Univ. Puerto Rico, Rio Piedras). *J. Agr. Univ. P.R. 56* (3) 267-79 (1972) (Eng). *CA 77*, 87020. Experiments were made over a period of 2 yr, using five levels of N (0, 200, 400, 600, and 800 lb/acre), 72 lb P/acre, and 600 lb K/acre, yearly. Grass was cut at two heights (2 and 6 inches) and at four intervals (30, 45, 60, and 90 days), and analyzed. Dry matter increased with N rates at both cutting heights. Protein increased up to the highest N application in all cases. The ratio of leaves to stems was unaffected by N rates. Leaves contained more protein than did stems in all cases. Dry matter increased but protein decreased as harvest intervals increased from 30 to 90 days. Nitrogen, P, and K decreased at both cutting heights and at all N rates as harvest interval increased from 30 to 90 days. Digestibility apparently decreased and lignin increased with length of harvest interval. Low cutting of grass produced higher yields than high cutting, especially as harvest interval increased from 30 to 90 days.

83 Comparison of Heavily Fertilized Pangolagrass and Stargrass Pastures under Humid Tropical Conditions. R. R. Caro-Costas, F. Abruna, and Jose Vicente-Chandler (Univ. Puerto Rico, Rio Piedras). *Agron. J. 65* (1), 132-3 (1973). *FA 6*, 855. There is little information on the comparative productivity of intensively managed pastures of pangolagrass (*Digitaria decumbens*) and stargrasss (*Cynodon Niem fuensis*) under humid tropical conditions. Therefore, an experiment was conducted to compare the productivity of these grasses growing on a steep ultisol when fertilized with 2.2 mt of 14-4-10/ha/yr and grazed by young cattle over a 2-yr period in the humid tropics of Puerto Rico. Stargrass produced 1514 kg/ha of beef/yr with daily gains of 0.60 kg/head, compared with 1062 kg/ha of beef and daily gains of 0.49 kg/head for pangolagrass. Stargrass had a carrying capacity of 7.4 steers (275 kg)/ha compared to 6.5 for pangolagrass. Throughout the yr, stargrass had higher dry matter and protein contents (ranging from 11.3 to 19.6%) than pangolagrass.

84 Effect of Heavy Rates of Fertilization on Beef Production and Carrying Capacity of Napiergrass Pastures Over Five Consecutive Years of Grazing Under Humid Tropical Conditions. R. Caro-Costas and Jose Vicente-Chandler (Univ. Puerto Rico, Mayaguez & Rio Piedras). *J. Agr. Univ. P.R. 56* (3), 223-7 (1972) (Eng). *FA 6*, 136. Intensively managed napiergrass pastures on steep slopes in the humid mountain region of Puerto Rico grazed by young growing cattle over a 5-yr period, produced an average of 947, 1281, and 1582 lb of gain in wt/acre/yr when fertilized annually with 1600, 2800, and 4000 lb of 14-4-10 fertilizer/acre, respectively. The pastures carried the equivalent of 2.22, 2.89, and 3.58 six-hundred-pound steers/acre throughout the yr and produced 6890, 8960, and 11,100 pounds of total digestible nutrients/acre/yr at the 1600-, 2800-, and 4000-lb fertilizer levels, respectively. Daily gains per head were not affected by level of fertilization, and averaged 1.31 lb. At the 4000-lb fertilizer rate the pastures maintained a minimum of three head/acre and produced 1582 lb of liveweight worth about $475 at current prices or $315 above fertilizer costs.

85 Effect of Four Levels of Fertilization on Beef Production and Carrying Capacity of Pangolagrass Pastures in the Humid Mountain Region of Puerto Rico. R. Caro-Costas, Jose Vicente-Chandler, and F. Abruna (Univ. Puerto Rico, Mayaguez & Rio Piedras). *J. Agr. Univ. P. R. 56* (3), 219-22 (1972) (Eng). *FA 6*, 135. Pangolagrass pastures on sloping lands in the humid mountain region of Puerto Rico responded in terms of beef production and carrying capacity, as well as economically, to applications of up to 2400 lb of 14-4-10 fertilizer/acre/yr, but there was no further significant increase due to heavier fertilization over 2 yr of experimentation. At the 2400-lb rate of fertilization, pangolagrass pastures carried the equivalent of two 600-lb steers/acre and produced an average of 871 lb of gain in wt/acre/yr with average daily gains/head of 1.2 lb.

86 Fertilizer Unlocks the Potential of Tropical Grasslands. Jose Vicente-Chandler. *World Farming 15* (1), 20-4 (1973). In Puerto Rico, yields of *Panicum maximum, Digitaria decumbens, Brachiaria mutica* Stapf, *Cynodon dactylon*, and *Brachiaria ruziziensis* grasses increased sharply with N levels up to 448 kg/ha, rising at a slower rate with higher N levels, while those of *Pennisetum purpureum* Schum increased rapidly with N rates up to 896 kg/ha. *Melinis minutiflora* Beauv. did not respond to N applications above 224 kg/ha. The grasses produced an average of about 30,000 kg/ha of dry forage when fertilized with 448 kg/ha N. Crude protein content of all the grasses increased sharply with N rates up to the highest levels tested averaging about 10% for 60-day-old grass receiving 896 kg/ha N. About 50% of the fertilizer N was recovered by the grasses. It is profitable to apply up to 4 tons/ha of 15-5-10 yearly to cut grasses in Puerto Rico.

87 The Role of Fertilizers in Hot Humid Tropical Pastures. Jose Vicente-Chandler. *Soil Crop Sci. Soc. Florida, Proc. 26*, 328-60 (1966). *Trop. Abstr. 23*, 990. Trials with grasses in Puerto Rico showed that forage production responded to N applications of up to 900 kg/ha/yr, and protein content even to N rates of 1800 kg. Applications of 450 kg K/ha/yr and of 73 kg P/ha resulted in responses in K-deficient, and not previously fertilized, soils, respectively. Liming of heavily fertilized soils increased exchangeable bases and decreased exchangeable Al contents, thus increasing yields of both grass and subsequently planted other crops. Yields could be increased from 5.6 tons of poor quality herbage to 45 tons of high quality forage/ha.

88 Effect of Two Cutting Heights, Four Harvest Intervals, and Five Nitrogen Rates on Yield and Composition of Congograss Under Humid Tropical Conditions. Jose Vicente-Chandler *et al* (Univ. Puerto Rico, Rio Piedras). *J. Agr. Univ. P. R. 56* (3), 280-91 (1972) (Eng). *CA 77*, 87021. Congograss was studied to determine effects of various factors, including N application rates of 0, 200, 400, 600, and 800 lb/acre/yr, 2 cutting heights (2 and 6 inches), and harvesting periods of 30,

45, 60, and 90 days. Cutting at 2 inches produced higher yields than at 6 inches in all cases. Yield increased but the N content of the forage decreased with length of harvest interval. Phosphorus and K decreased and lignin increased with length of harvest interval, but Ca and Mg were not affected. Yield of grass increased with N applications up to 600 lb/acre in all cases, and protein content increased up to 800 lb. Recovery of fertilizer N in the forage averaged~60% at the 600-lb rate. Dry matter and P decreased with increased N application, but Ca, Mg, and K were not affected. With 600 lb N/acre, and close cutting every 45 to 60 days, production was~30,000 lb of dry forage, containing 9.5% protein/acre.

TRINIDAD

89 The Effect of Retarding Nitrification of Added Fertilizer Nitrogen on the Yield and Nitrogen Uptake of Pangolagrass *(Digitaria decumbens)*. C. C. Weir and J. G. Davidson. *Trop. Agr. (Trinidad) 45* (4), 301-6 (1968). *Trop. Abstr. 24*, 372. In Trinidad, urea alone or treated with a nitrification inhibitor, 2-amino-4-chloro-6-methyl pyrimidine, was applied to pangolagrass as a single dressing or divided either into two dressings applied every 3 months, or into three dressings applied every 2 months. Grass was cut six times at 30-day intervals, yields were measured, the N-content determined and the N-uptake calculated. Splitting the N-fertilizer into two or three dressings significantly increased yields of forage and recoveries of applied N more than the single dressing. Mixing the nitrification inhibitor with urea, applied as a single dressing, significantly increased yields of forage and recovery of applied N.

UNITED STATES

90 Coastal Bermudagrass Forage Production and Chemical Composition as Influenced by Potassium Source, Rate, and Frequency of Application. W. E. Adams, A. W. White, R. A. McCreery, and R. N. Dawson (U.S. Dep. Agr., Watkinsville, Ga.). *Agron. J. 59* (3), 247-50 (1967). *CA 67*, 42953. The influence of K source, rate, and frequency of application was studied on intensively managed coastal bermudagrass grown on Cecil sandy loam soil. The N, P, and K contents of the forage and the forage production were not influenced by the Cl^- or SO_4^{2-} source of K. The 185 kg K/ha rate applied as KCl in four equal splits, that is, at the initiation of spring growth and after each of the first three harvests, produced about 15,700 kg of forage/ha and the most efficient K utilization. Efficiency was reflected by more uniform seasonal forage distribution and a more uniform K content (average 1.5%) throughout the growing season as contrasted with applying all the K in the spring. This management practice of splitting the K application increased the kg of forage produced/cm of rainfall by 14% and the efficiency of applied K by 14%. The K-Ca pyrophosphate source produced significantly more forage with a significantly lower K content than either the SO_4^{2-} or Cl^- sources of K; 185 kg of K/ha, applied in four equal splits rather than at one time, doubled the exchangeable K in the surface 15 cm of soil, produced earlier spring growth of the coastal bermudagrass and a higher forage yield in the first harvest.

91 Soluble and Slow-Release Nitrogen Fertilizer Effects on Grass Forage, as Influenced by Rate and Placement. S. E. Allen, G. L. Terman, and C. M. Hunt (Tennessee Valley Authority, Muscle Shoals, Ala.). *J. Agr. Sci. 77* (3), 397-404 (1971). *FA 5*, 469. Soluble ammonium nitrate (AN) and urea were compared with slow-release oxamide and sulfur-coated urea (SCU) as N sources for clipped annual ryegrass (*Lolium multiflorum*) or common bermudagrass (*Cynodon dactylon*) in four greenhouse experiments. Mixed and surface applications of a wide range of N rates were evaluated for 9 to 14 cuttings of grass forage. Both granular oxamide and SCU exhibited slow-release N properties, especially when surface-applied. Uptake distribution of N with high application rates of AN and urea tended to resemble that of the slow-release sources. Slow-release properties of oxamide and SCU were accentuated at high application rates. Lower N recovery from surface-applied urea than from AN indicated volatilization loss of urea N. Volatilization loss also occurred with oxamide, but low N recovery from oxamide and SCU resulted largely from incomplete dissolution of the granules during the 18- to 34-week experimental periods. Very low N recovery was obtained from urea formaldehyde having an activity index of 42.

92 Response of Lehmann Lovegrass to Time of Fertilizer Application. Bahe Billy, J. L. Stroehlein, and P. R. Ogden. *J. Range Manage. 26* (3), 222-4 (1973). *FA 6*, 1457. On a desert grassland site in southern Arizona, production of Lehmann lovegrass (*Eragrostis lehmanniana*) was significantly increased by applications of 30-10-0 fertilizer as late as July 22. Seed yields were least with later dates of fertilization. Nitrogen and P contents of the plants were increased within 1 week after application; thereafter they generally declined. Nitrate-N and available P in the surface 4 in. of soil increased immediately after fertilization, and the nitrate–N then decreased rapidly. Plots fertilized at later dates generally reached their peak yield and higher N and P contents later and remained greener into the fall months than those fertilized at the beginning of the rainy season. Herbage growth of forbs the following spring was greater on fertilized plots than on control plots, but data were very variable and not significant. No residual response of Lehmann lovegrass was found the second summer growing season after fertilization, probably a result of the dry summer.

93 Response of Brunswickgrass [*Paspalum nicorae* (Parodi)] to N Fertilization and Intense Clipping. E. R. Beaty, J. D. Powell, and R. M. Lawrence (Univ. Ga., Athens). *Agron. J. 62* (3), 363-5 (1970). *FA 3*, 1338. A number of accessions of brunswickgrass, *Paspalum nicorae* (Parodi) have been introduced into the southeastern United States in recent yr. It is a tropical and subtropical forage species on which little research has been reported. In this investigation the grass was fertilized with 0, 112, 224, and 336 kg N/ha and clipped at 1-, 2-, 3-, 4-, 5-, and 6-week frequencies at approximately 3 mm height. Each increment of N increased forage production significantly but at a reduced rate. The forage yields increased as the clipping interval was lengthened from 1 to 6 weeks with the largest increase between the 2- and 3-week frequencies. Tillers/dm^2 and rhizomes/ha were not influenced by either N rate or clipping frequency. Roots/ha were reduced by the 1- and 2-week frequencies and at the lowest N rate. However, all treatments appeared to have sufficient roots to prevent deterioration to the sods.

94 Role of Pensacola Bahiagrass Stolon-Root Systems in Fertilizer Nitrogen Utilization on Leon Fine Sand. W. G. Blue (Florida Agr. Exp. Sta., Univ. Florida, Gainesville).

Agron. J. 65 (1), 88-91 (1973). *CA 78*, 123247. An experiment was conducted with Pensacola bahiagrass (*Paspalum notatum*) on Leon fine sand for 6 yr to determine residual effects of applied N on forage N uptake, and changes in stolons, roots, and soil N. Nitrogen was applied at 0, 112, 224, and 448 kg/ha/yr. Except for the control, paired plots were used at each N rate, N fertilization was discontinued on one of each treatment pairs for 2 yr to determine the residual effect of N. The residual effect of N was small for all treatments, amounting to 8, 41, and 95 kg/ha total N in harvested forage above the control for the 2-yr period for the 112, 224, and 448 kg N rates, respectively. Unrecovered N was approximately 200, 350, and 770 kg/ha for the three treatments, respectively. Nitrogen lost from the stolon-root systems during the 2 yr through decrease in mass and N concentrations was 60, 100, and 190 kg/ha, respectively. Lack of residual effect on plant growth confirmed that little available N was in the soil profile to rooting depth. Leaching appears to have limited importance when N is applied to well-established perennial grass pastures during the growing season. Conditions imposed in this soil by high water table, large amounts of plant residues, and rapid decomposition during the summer season could make denitrification a significant factor.

95 Manganese-Silicon Interaction and Its Effect on Growth of Sudangrass. J. E. Bowen (Hawaii Agr. Exp. Sta., Univ. Hawaii, Hilo). *Plant Soil 37* (3), 577-88 (1972). *CA 78*, 70677. Sudangrass (*Sorghum sudanese*) seeds were germinated and transferred to nutrient solutions. Manganese was added as $MnSO_4 \cdot H_2O$ and Si as Na silicate. After 6 weeks in the growth chamber (28°, 80% relative humidity, and 2000 ft-candles), the plants were harvested, dried, and analyzed by atomic absorption spectrophotometry. Silicon was determined on the ash by the silicomolybdate method. The maximum growth was observed at 0.25 to 0.50 mg Mn/l. At 0.25 mg Mn/l., Si (0-10 mg/l.) uptake decreased the plant growth by 51%. At the toxic Mn concentration of 1 mg/l., addition of 3 mg Si/l. increased top growth by 21%. Addition of Si decreased the Mn content of the plants and likewise Si alleviated the toxicities of Cu and Zn. The essentiality of Si for sudangrass was not verified.

96 Management Factors Affecting Coastal Bermudagrass Yield and Water Use. J. R. Carreker *et al* (Agr. Res. Serv., U.S. Dep. Agr., Athens, Ga.). *J. Soil Water Conserv. 27* (1), 14-17 (1972). *FA 5*, 838. Coastal bermudagrass was grown with and without irrigation, clipped at intervals of 2, 4, and 6 weeks, and fertilized with 200-100, 600-300, 1000-500 lb/acre of N and K, respectively. Forage yields and water use efficiency were increased by irrigation, length between clipping, and increased NK level. Average annual yields ranged from 1.7 ton/acre with 200-100 lb/acre of N and K, 2-weeks clipping, and no irrigation to 9.2 ton/acre with 1000-500 lb/acre of N and K, 6-weeks clipping, and irrigation.

97 Nitrogen Fertilization, Harvest Management, and Utilization of 'Midland' Bermudagrass [*Cynodon dactylon* (L.) Pers.]. A. M. Decker *et al. Maryland Univ. Agr. Exp. Sta. Bull. 487*, 71 pp. (1971). *Soils Fert. 35*, 3528. Field experiments were conducted at four locations to study the effects of up to 800 lb N/acre, number of harvests, and stubble heights of 1, 2, or 4 inches. Ammonium nitrate was superior to urea as source of N. Increasing the number of harvests from 3 to 7 improved N recovery and decreased yields by about 20% but nearly doubled the crude protein content. Yields leveled rapidly above 400 lb N/acre. Digestibility studies were also conducted.

98 Crop Responses and Related Benefits from SCU (Sulfur-Coated Urea). R. B. Diamond and F. J. Myers. *Sulphur Inst. J. 8* (4), 9-11 (1972). *CA 78*, 96528. Sulfur-coated urea (SCU) was tested as a N-source for several crops under different soil and climatic conditions. It was found that SCU gives a higher yield of rice, bermudagrass, and Hawaiian sugarcane than to uncoated urea. In all the tests, it was also found that to get a high yield fewer applications of SCU than of uncoated urea are needed.

99 High Rates of Nitrogen Fertilization Influence Coastal Prairie Range. D. L. Drawe and T. W. Box (Welder Wildlife Found., Sinton, Texas). *J. Range Manage. 22* (1), 32-6 (1969). *FA 2*, 1527. Nitrogen at four rates, 100, 300, 600, and 900 lb/acre, and a combination of 900 lb N, 100 lb P_2O_5/acre were applied to a bunchgrass-annual forb community in a randomized complete block design in 1965. Fertilization with N and N with P increased the total production in all cases, although grass production decreased in 1967. Nitrogen content and protein content of forage increased with all rates of fertilization. Phosphorus content increased only when P was added to the N fertilizer. There was no change in K content with any treatment. Residual amounts of P occurred in the soil one yr after fertilization. Cattle grazed fertilized strips more heavily than the control plots. Both the percent utilization and pounds of herbage increased with fertilization rate. There was no difference in the amount of residual material left after grazing.

100 Nitrogen and Moisture Requirements of Coastal Bermuda and Pensacola Bahia. E. M. Evans *et al. Ala. Agr. Exp. Sta., Bull. 337*, 19 pp. (1961). (Auburn Univ., Auburn, Ala.) An experiment was begun in 1956 to determine the response of coastal bermudagrass and Pensacola bahiagrass to fertilizer N with and without irrigation. The irrigated plots received an average of 12 applications of water totaling 11 inches each yr. Water was applied by sprinkler irrigation when 30% of available water in the upper 24 in. of soil was used. Ammonium nitrate was the source of N. One-fifth of the total N was applied before growth started in the spring; the remainder was applied in four equal applications following the first four harvests. All plots received fertilizer equivalent to 225 lb of P_2O_5 and 450 lb of K_2O/acre annually in 1956 and 1957. In 1958 and 1959, mineral fertilization was increased to 280 lb of P_2O_5 and 560 lb of K_2O/acre annually. Phosphate and K were applied in three equal applications made before growth started in the spring and after the first and third cuttings. All plots received 1 ton of lime/acre in each of the yr of 1955, 1957, and 1958.

101 *In Vitro* Dry Matter Digestibility of 'Midland' Bermudagrass Grown at Several Levels of Nitrogen Fertilization. H. A. Fribourg, N. C. Edwards, and K. M. Barth (Univ. Tennessee, Knoxville). *Agron. J. 63* (5), 786-8 (1971). *FA 4*, 2104. 'Midland' bermudagrass [*Cynodon dactylon* (E.) Pers.] was grown at three locations without and with N fertilizer applied at several rates; four replications of a randomized complete block (RCB) design were used at each location. Dry matter yields of about 4 ton/ha were produced by the no-N treatment. This was doubled by adding 133 kg N/ha and doubled again when 400 kg N/ha were added. The 800 kg N/ha treatment produced 2.5 ton/ha more than the 400 kg/ha treatment. To ascertain the effects of N fertilization on *in vitro* dry matter digestibility (DDM), samples were composited from the four-field replications of each harvest at each location. Four aliquots, one for each of four replications of a 9

x 9 balanced lattice design (173% efficiency compared to RCB) were taken from each composite sample. Each replication was a run using one inoculum from a rumen-fistulated steer fed Midland bermudagrass. The average DDM increased from about 37 to 46% over the range of applied N. The greatest increase occurred as the N rate was increased from 133 to 400 kg/ha. The yield of DDM was increased from about 1.5 to 9.0 ton/ha with increasing N applications.

102 Effect of Phosphate Fertilizers on Pangolagrass Pastures and Beef Production. E. M. Hodges *et al. Fla. Agr. Exp. Sta., Circ. S190*, 11 pp. (1968). (Univ. Fla., Gainsville). *FA 4*, 710. In field trials on fine sandy soil, P was applied as superphosphate with or without lime at 50 lb P_2O_5/acre/yr in 1947-54 and at 25 lb/acre/yr in 1955-58; as basic slag at 500 lb/acre/yr in 1947-54 and 300 lb/acre in 1955-58; as rock phosphate at 1 ton/acre in 1947, 1950, and 1953; and as colloidal phosphate at 2400 lb/acre in 1949, 800 lb/acre in 1952, 2400 lb/acre in 1953, and 1000 lb/acre in 1957. The fields were grazed during 1955-65 using the put-and-take method. Forage yields during 1955-58 were highest on plots receiving superphosphate + lime, concentrated superphosphate, basic slag, or rock phosphate. Yields from pastures given P were 47% above those given no P (6 and 4.08 tons/acre, respectively); during the residual period (1958-65) the difference was 25%. There were no significant differences in herbage crude protein contents, which were 4.9-5.6% in 1955-58 and 5.3-6.1% in the residual period. Forage P contents were nutritionally adequate during 1955-58 on all plots receiving P but declined sharply during the residual period on all plots except those receiving rock and colloidal phosphate. Beef gains/acre during 1955-58 were 234 lb on plots receiving P and 122 lb on control plots. Respective values during the residual period were 185 and 116 lb.

103 Bahiagrass for Forage in Alabama. C. S. Hoveland. *Ala. Agr. Exp. Sta., Circ. 140*, 19 pp. (1961). (Auburn Univ., Auburn, Ala.). Bahiagrass requires fertilization for satisfactory establishment and production, preferably according to soil test recommendations. In the absence of a soil test, an application of 16 lb of N and 48 lb/acre each of P_2O_5 and K_2O is recommended. It may be necessary to apply lime at the rate of 1 ton/acre on sandy soils and 2 tons/acre on loam soils. As soon as the stand is established, a topdressing of 45 lb of N is needed. In succeeding yr, a spring application of 56 lb/acre each of P_2O_5 and K_2O is recommended. In the absence of legumes and if the grass is to be used for grazing only, an application of 30 lb/acre of N is needed in April and again in June. For production of grazing and hay, 40 to 50 lb/acre of N is needed several times during the season up to a total of 200 lb. An application of 56 lb/acre each of P_2O_5 and K_2O is necessary before planting where winter legumes are grown on the grass sod. When legume stands are good, the spring topdressing of N can be omitted. For high summer grass production, however, the pasture should be topdressed in June.

104 Land Disposal of Liquid Sewage Sludge: I. The Effect on Yield, *in vivo* Digestibility, and Chemical Composition of Coastal Bermudagrass (*Cynodon dactylon* L. Pers.). L. D. King and H. D. Morris (Univ. Georgia, Athens). *J. Environ. Qual. 1* (3), 325-9 (1972). *FA 6*, 167. The disposal of liquid sewage sludge on established coastal bermudagrass sod was studied over a 2-yr period. Rates of sludge application up to 20 cm/yr were compared with a conventional fertilizer treatment. In 1969 there were no significant differences among the three highest sludge rates and all sludge rates were superior to chemical fertilizer (224-37-97 kg/ha NPK) in forage production. In 1970 no significant differences were found among the three top rates of sludge and a higher rate of chemical fertilizer (358-112-224 kg/ha NPK) that was used. Sludge applications had little effect on *in vivo* digestibility of the forage. The K level of the forage was initially increased by sludge applications but steadily declined during the last half of the 1969 season and the entire 1970 season. Sludge applications increased the N and Na level of the forage but had little or no effect on P, Ca, Mg, Mn, B, Cu, Mo, and Ni. Zinc content of the forage increased with increasing sludge rate and number of applications through the second clipping in 1970. Although Zn levels of 340 ppm were found, no reduction in yield resulted. There was no significant survival of coliform bacteria on the forage at harvest. Results of the investigation indicate that coastal bermudagrass is a well-adapted crop for sludge disposal areas.

105 Soil Salinity Effects on Absorption of Nitrogen, Phosphorus, and Protein Synthesis by Coastal Bermudagrass. G. W. Langdale and J. R. Thomas (U.S. Dep. Agr., Weslaco, Tex.). *Agron. J. 63* (5), 708-11 (1971). *FA 4*, 2138. The interaction of artificially salinized soil and NP fertilization on dry matter production and protein synthesis of coastal bermudagrass [*Cynodon dactylon* (L.) Pers.] was studied in a greenhouse. Saline solutions were prepared in concentration multiples with the same ionic ratios as the available irrigation water to develop four treatments with electrical conductivities (EC) of 0, 4.8, 9.6, and 14.4 mmhos/cm. After saline-water equilibration of a Brennan fine sandy loam soil (Typic Haplustalf), fertilizer treatments were applied in a factorial arrangement with N rates of 0, 67, 133, and 200 mg/kg of soil and P rates of 0, 20, 40, and 60 mg/kg of soil. No response was obtained from P fertilization. Significant interactions occurred for both dry matter and protein-N yields with soil salinity and N supply treatments. Soil salinities of 5.3 and 6.6 mmhos/cm yielded the most dry matter and protein N, respectively, in the presence of N fertilizer. Reduction in soluble N (nonprotein) occurred at the most efficient levels of protein-N synthesis. Although N requirements decreased as soil salinity increased, N fertilization offset effects of salinity up to 9.6 mmhos/cm. Dry matter and protein syntheses were seriously restricted at the 14.4 mmhos/cm salinity level; however, salinity levels did not restrict N absorption by coastal bermudagrass.

106 Fertilization of Annual Rangeland with Chicken Manure. C. M. McKell *et al* (Univ. California, Riverside). *J. Range Manage. 23* (5), 336-40 (1970). *FA 3*, 2038. Rates of 0, 1, 2, and 4 tons of chicken manure/acre were compared with equal amounts of nutrients from ammonium nitrate and superphosphate (70 N + 40 P, 140 N + 80 P, and 280 lb N + 160 lb P/acre) for annual rangeland near San Diego, California. The value of chicken manure was equal to equivalent rates of N and P from inorganic fertilizers for increasing forage yields. A slower release of nutrients occurred with manure, but forage response was the same as for the inorganic fertilizers over a 3-yr period. An average of 1600 lb extra forage was obtained/ton of chicken manure.

107 Influence of Sulfur Sources and Magnesium on Forage Yields of Coastal Bermudagrass [*Cynodon dactylon* (L.) Pers.]. J. E. Matocha (Agr. Res. Ext. Center, Texas A & M Univ., Overton). *Agron. J. 63* (3), 493-6 (1971). *FA 4*, 1399. Yield response to sources and rates of S at three levels of Mg was studied on a Troup loamy fine sand. Powdered gypsum, prilled elemental S, and K-Mg were each applied at 0, 50, and

200 kg S/ha. Forage yields were taken for 2 yr following application of S and Mg. Yields in the first season were highest when 50 kg S/ha as gypsum was applied. The high rate of gypsum decreased yields in the first season but increased production in the second yr. Prilled elemental S had no effect on yield the first yr, but gave significant response in the second yr. Magnesium decreased yields in both yr. Addition of gypsum reduced the adverse effects of Mg and resulted in a significant S x Mg interaction on yields in the second yr. Elemental S partially corrected the imbalance in plots receiving Mg alone. Magnesium failed to accentuate the response to elemental S and total yields were substantially less than for Mg plus gypsum or K-Mg.

108 Recycling and Recovery of Nitrogen, Phosphorus, and Potassium by Coastal Bermudagrass. I. Effect of Sources and Rates of Nitrogen Under a Clipping System. J. E. Matocha, F. M. Rouquette, Jr., and R. L. Duble (Agr. Res. Ext. Cent., Texas A and M Univ., Overton). *J. Environ. Qual. 2* (1), 125-9 (1973). *CA 79*, 4241. *Cynodon dactylon* (bermudagrass) grown on Troup loamy fine sand was treated with 3 N sources [NH_4NO_3, $(NH_4)_2SO_4$, and urea] at 0, 280, 560, and 840 kg N/ha. The recovery of N ranged from 30 to 110%, and the N recovery from fertilizer materials was in order: $(NH_4)_2SO_4 > NH_4NO_3 >$ urea. The effects of carriers on P recovery were: $NH_4NO_3 \geqslant (NH_4)_2SO_4 >$ urea and ranged from 10 to 52% of applied P. The recovery of applied K ranged from 76% for urea to 113% for $(NH_4)_2SO_4$. With split applications of NH_4NO_3, approximately 40% of the applied P and 90% of applied K were recovered by bermudagrass. Ammonium sulfate gave a greater accumulation of soil N than NH_4NO_3 or urea, whereas extractable soil P and K were highest for NH_4NO_3.

109 Sulfur-Coated Urea: A Slow-Release Nitrogen Source for Grass. D. A. Mays (Tennessee Valley Authority, Muscle Shoals, Ala.). *Proc., Int. Grassland Cong., 11th*, pp. 428-30 (1970). Sulfur-coated urea was compared with ammonium nitrate and uncoated urea at Muscle Shoals for production of tall fescue (*Festuca arundinacea*) and coastal bermudagrass (*Cynodon dactylon*). When these N sources were compared on tall fescue, spring forage production was less but summer and fall production was higher from sulfur-coated urea than from the soluble N sources. In trials on coastal bermudagrass, the coated product was superior in total yield and uniformity of seasonal production when all sources were applied in a single spring application, but not with four split applications.

110 Winter Application of Nitrogen Satisfactory for Tall Fescue. D. A. Mays (Tennessee Valley Authority, Muscle Shoals, Ala.) and E. M. Evans (Auburn Univ., Ala.). *Highlights Agr. Res. 16* (4), 10 (1969). *FA 2*, 924. Nitrogen fertilization rates of 75 or 150 lb/acre from NH_4NO_3 were used for established fescue on Lawrence silty clay loam on Dec. 15, Jan. 15, Feb. 15, and March 15. Phosphorus and K were applied annually at P 22 and K 83 lb/acre. Forage was harvested about May 1, July 1, and Oct. 1. Winter application proved of value, but the date had little effect on total yield response to NH_4NO_3. Urea, however, was less effective if applied in Dec. or Mar. than if put on in Jan. and Feb., and was generally less effective than NH_4NO_3 in improving yields. Forage yield response to the first 75 lb N/acre from NH_4NO_3 averaged ~1800 lb/acre in May and 700 in July. The second 75 lb of N/acre increased yields an additional 1300 lb/acre in May and 600 in July, for a total of ~1 ton of dry forage. The second 75 lb increment of N also gave a decided improvement in forage crude protein content. Thus N should be applied to fescue pastures in late Aug. or early Sept. to stimulate fall growth and again in the winter to help spring production.

111 Response of Coastal Bermudagrass to Nitrogen in Sulfur-Coated Urea, Urea and Ammonium Nitrate. D. A. Mays and G. L. Terman (Tennessee Valley Authority, Muscle Shoals, Ala.). *Sulphur Inst. J. 5* (3), 7-10 (1969). *FA 3*, 404. Coastal bermudagrass on field plots of Sango silty clay loam was treated with 224 or 448 kg/ha of N in 1, 2, or 4 applications using ammonium nitrate (AN), uncoated urea (UCU), or sulfur-coated urea (SCU) as N sources. The experiment was conducted from 1966 to 1969 at Muscle Shoals with N applied the first 3 yr only. SCU contained 40-45% S as elemental S coated on urea granules. UCU produced significantly less forage than AN or SCU when all were applied as a single spring application. A single spring application of SCU produced four harvests of forage as uniform in yield as four split applications of AN. Apparent N recovery was as high for the single application of SCU (66-70% recovery) as for four applications of AN (55-65%).

112 New Role for an Old Jungle. P. S. Motooka *et al. World Farming 10* (8), 26-9 (1968). *Trop. Abstr. 25*, 1653. In Hawaii on steep-sloped land and under a rainfall of 2500 mm/yr, a cheap technique to reclaim old jungle and bush areas into pastures on Al/Fe latosols is described. Attention is paid to: integration of herbicidal treatment, effects of burning, pasture species, seed pelletizing, inoculation, fertilizing, and sowing. After clearing, immediate aerial sowing of a mixture of *Rhizobium*-treated, pelleted seeds of *Desmodium intortum*, green panic seed (*Panicum maximum*), and granular triple superphosphate showed most satisfactory results in the presence of adequate moisture. Diammonium phosphate was applied at a rate of 2.2 kg/ha, 2 months after sowing. Significance of ash and liming is discussed. The pasture species failed to establish on locations with *Setaria* and *Paspalum* spp. at sowing, or where staghorn litter (*Dicranopteris linearis*) remained.

113 Pasture Establishment in Tropical Brushlands by Aerial Herbicide and Seeding Treatments on Kauai. P. S. Motooka *et al. Hawaii Agr. Exp. Sta. Tech Prog. Rep 165*, 3-18 (1969). *Trop. Abstr. 25*, 352. In Hawaii, a study was made on clearing and reclaiming of jungle lands. Aerial application of herbicides appeared to be attractive. An area of 16 ha treated twice with fenoprop at 4.5 kg active ingredient/ha gave good control of guava (*Psidium guajava*), *Pandanus* species, and *Lantana camara*. After that, the area was burned and pasture was established by aerial methods. Nitrogen was applied at 36 kg/ha, and P at 96 kg/ha The pasture seeds were mixed with granulated triple superphosphate for aerial sowing. *Panicum maximum*, *Stylosanthes gracilis*, *Desmodium intortum*, and white clover gave good germination and early growth. Growth was excellent under burned trees and in areas not subjected to intensive sunlight and dehydration.

114 Nutritional Influences on Cold Hardiness of St. Augustinegrass (*Stenotaphrum secundatum*). S. A. Reeves and G. G. McBee (Texas Agr. Exp. Sta., College Station). *Agron. J. 64* (4), 447-50 (1972). *FA 5*, 1775. The study was designed to determine the effect of late-fall fertilization on winterkilling of St. Augustinegrass (*Stenotaphrum secundatum*). Data on which to base recommendations for late-season fertilization of this grass in the South are inadequate. Nitrogen, P, and K, and combination of these were applied at different intervals at the rate of 1.47, 0.64, 1.23 kg/100 m^2/month, respectively,

through December 1968 to plots in the College Station area. Plots to which N was applied in November and December showed the greatest topkill after each freeze, but were the first to resume growth when the temperature increased. Late application of N fertilizer, either in combination with P and K or separate, resulted in the grass remaining green longer in the fall and resuming growth faster in the spring. St. Augustinegrass lost the majority of its cold hardiness between 48 and 72 hr at 25° under the conditions of this study. Samples of tissues were collected to determine levels of the above-named elements that were present. Chemical analysis of material collected before the first freeze showed higher N levels in the tissue under late N fertilization. A direct relationship appeared to exist between the tissue N level and levels of K and P. Where higher levels of tissue N were obtained, generally higher levels of P and K were also obtained.

115 The Availability to Forage Plants of Accumulated Phosphorus in Leon Fine Sand. S. Rodulfo and W. G. Blue. *Soil Crop Sci. Soc. Fla. Proc. 30*, 167-74 (1971). *Trop. Abstr. 27*, 2676. In Florida, fertilizer P accumulates at the surface of Leon fine sand under perennial pastures as a result of repeated surface liming and fertilizing. Pot experiments with this soil and various fodder crops and determinations of total P and total P uptake by the plants indicate that P fertilizing levels can be reduced as soil P accumulates and that above 300 ppm of total soil P, response to P fertilizers is unlikely.

116 Effect of Nitrogen, Phosphorus, and Potassium Fertilization and Stages of Maturity on Chemical Composition of Fiber in Kleingrass (*Panicum coloratum*). F. M. Rouquette, Jr., E. C. Holt, and W. C. Ellis (Agr. Res. Ext. Cent., Texas A and M Univ., Overton). *Agron. J. 64* (4), 456-9 (1972). *CA 77*, 87053. Studies were conducted to determine the influence of N, P, and K fertilization and different stages of growth on the nutritional quality of kleingrass (*P. coloratum*) forage. Nitrogen rates ranged from 28 to 560 kg/ha with additions of 24 and 73 kg P/ha, and 0, 46, and 139 kg K/ha. Leaf-stem separations were made at each harvest date and cellular (neutral detergent extract, NDE) and cell wall constituents (neutral detergent fiber, NDF) were determined on the plant parts. The NDF fraction was then sequentially partitioned into hemicellulose, cellulose, lignin, and ash. Levels of N or P were significantly negatively correlated with percent NDF of leaf laminae. Chemical components of stem fiber were not altered by fertility levels. On a whole-plant basis percent NDF was reduced ~5% by additions of N. Percent NDF in leaves and stems increased with chronological and morphological age. The holocellulose content of leaves remained relatively constant throughout the study period; with advancing maturity, however, the hemicellulose fraction accounted for a greater portion of the NDF than did cellulose. The hemicellulose:cellulose ratio increased to approximately 1.7:1 in leaves, but remained at 1:1 in stems with increasing maturity. The leaves apparently had more influence on decreasing NDF of the whole plant under fertilization, whereas, stems were the dominant factors involved in increasing NDF of the whole plant with advancing maturity.

117 Recycling and Recovery of Nitrogen, Phosphorus, and Potassium by Coastal Bermudagrass. II. Under Grazing Conditions with Two Stocking Rates. F. M. Rouquette Jr., J. E. Matocha, and R. L. Duble (Agr. Res. Ext. Center, Texas A and M Univ., Overton). *J. Environ. Qual. 2* (1), 129-32 (1973). *CA 79*, 4240. The pastures located on Troup loamy fine sand were fertilized with 224, 48, and 93 kg/ha of N, P, and K, respectively, each yr. The stocking rates were 5 and 3 animals/ha. Recycling of plant nutrients on the high-stocked pastures was approximately twice as high during a dry yr and approximately 10% higher during a wet yr than on the low-stocked pastures. Recoveries of applied nutrients, during the dry yr were 84, 50, and 155% for N, P, and K, respectively; during the wet yr they were 180, 73, and 173% for N, P, and K, respectively. On the high-stocked pasture total soil N was 2-fold, soil-available P 3-fold, and available K 2-fold that on the low-stocked pasture.

118 Potassium Fertilization Influence on Winter Survival of Pangolagrass. O. C. Ruelke. *Soil Crop Sci. Soc. Fla. Proc. 26*, 231-8 (1966). *Trop. Abstr. 23*, 992. From 1961 to 1964, trials on winter survival of pangolagrass (*Digitaria decumbens*) in northern Florida showed that N, supplied in the autumn after the hay had been harvested, had a detrimental effect whereas application of K at a rate of 67 kg K_2O/ha generally caused a better recovery of cores in Dec. However, K did not prevent injury throughout the entire winter. While 56 kg N/ha was not seriously detrimental, less than 10% of the grass survived at a rate of 168 kg N/ha. Differences in winter temperatures and spring precipitation during these yr influenced both survival and recovery.

119 Winter Turf Development on Dormant Bermudagrass as Influenced by Summer Cultivation and Winter N Fertilization. R. E. Schmidt and J. F. Shoulders (Virginia Polytechnic Inst., Blacksburg). *Agron. J. 64* (4), 435-7 (1972). *Soils Fert. 36*, 331. The removal of the thatch of a bermudagrass turf by frequent summer aeration and soil topdressing improved the winter quality of cool season turf overseeded in October with ryegrass and red fescue. Excessive N fertilization in winter, especially on heavily thatched areas, reduced winter turf coverage. The best transition from cool season turf to bermudagrass occurred when the cool season grass persisted into the summer.

120 Humic-Fulvic Acid Content in Soils as Related to Ley Clipping Management and Fertilization. K. H. Tan *et al* (Dep. Agron., Univ. Georgia, Athens). *Soil Sci. Soc. Amer., Proc. 36* (4), 565-7 (1972). *CA 77*, 87002. Studies on changes of humic-fulvic acid content in a Eustis loamy sand due to weekly clipped Pensacola bahiagrass (*Paspalum notatum*) and fertilization showed that N fertilization encouraged formation of humic acid and decreased fulvic acid contents in soils. Longer clipping intervals tended to increase the amount of both humic and fulvic acid when N fertilization was applied. A significant positive correlation between N or organic P contents of the soil and humic/fulvic acid ratios indicated that humic-fulvic acid formation was affected by soil N content (or organic P). A correlation also existed between humic-fulvic acid and pH, in which a decrease of soil pH resulted in an increase of humic/fulvic acid ratio.

121 Variability in Grass Forage Clipping Experiments Comparing Fertilizer Rates and Sources. G. L. Terman (Tennessee Valley Authority, Muscle Shoals, Ala.). *Agron. J. 64* (1), 20-3 (1972). *FA 5*, 645. Variability in yields of dry forage and in uptake of nutrients was studied in 10 greenhouse pot and three field plot experiments comparing various rates and sources of N, P, K, or Zn for grasses clipped three to eight times. Standard deviation (SD) increased, in general, with increase in mean yields of individual clippings. Standard deviation for cumulative yields, however, decreased or remained about the same with increase in cumulative mean

yield, or increased proportionately less than did yield. Coefficients of variability (CV) decreased in all experiments with increase in cumulative mean yields. These results indicate that statistical analyses of cumulative yields are usually more meaningful and result in less percentage variability than do analyses of individual clippings yields. Experimental error decreased in the order sorghum-sudangrass hybrid [*Sorghum bicolor* (L.) Moench x *Sorghum vulgare sudanense*]> bermudagrass (*Cynodon dactylon* L.)> ryegrass (*Lolium multiflorum* Lam.) in greenhouse experiments and sorghum-sudangrass hybrid > bermudagrass > fescue (*Festuca* sp.) in field experiments.

122 Leaching of Soluble and Slow-release Nitrogen and Potassium Fertilizers from Lakeland Sand Under Grass and Fallow. G. L. Terman and S. E. Allen (Tennessee Valley Authority, Muscle Shoals, Ala.). *Soil Crop Sci. Soc Fla., Proc. 30*, 130-40 (1971). *CA 77*, 150895. Two greenhouse lysimeter experiments on Lakeland sand under grass and fallow were conducted to study the effectiveness of uncoated and S-coated urea and KCl. Annual ryegrass fertilized with uncoated NH_4NO_3 (AN) and urea and S-coated urea (SCU) was grown in the first experiment in which significant amounts of N were leached only with the 4-in. rate of water from the higher rates of AN and urea; this was reflected in lower yields and N uptake. SCU was more effective than AN or urea at the higher water rate and highest (1460 mg) N rate. In the second experiment with common bermudagrass fertilized with uncoated and S-coated KCl, leaching of K under fallow and total yields and K uptake increased linearly with the rates of 182, 365, and 750 mg K applied/lysimeter. Much of the K leached from the sand under fallow, but leaching was negligible under bermudagrass. Adding N and KCl in split applications increased K leaching under fallow. Leaching was also higher with 4 than with 2 in. water/week.

123 Effects of Harvesting Interval, Height of Cut, and Nitrogen Fertilization on the Performance of *Desmodium intortum* Mixtures in Hawaii. A. S. Whitney (Hawaii Agr. Exp. Sta., Kula). *Proc. Int. Grassl. Congr., 11th*, pp. 632-6 (1970). *Desmodium intortum* mixtures with pangola- and kikuyu-grasses were compared with the grasses alone under different intensities of cutting, with and without added N. Ten-week cutting intervals resulted in higher yields than 5-week intervals but rendered grass-alone treatments unpalatable to cattle. The 13-cm cutting height was consistently better than 5 cm for *D. intortum*, but the differences were nonsignificant. Nitrogen fertilization reduced the legume component to less than 10% in the 10-week treatments and less than 1% in the 5-week treatments. Under optimum management without N fertilization, *D. intortum* fixed over 300 kg of N/ha/yr in kikuyu mixtures.

124 Pangolagrass Performance under Different Levels of Nitrogen Fertilization in Hawaii. A. S. Whitney and R. E. Green (Univ. Hawaii, Kula). *Agron. J. 61* (4), 577-81 (1969). *FA 2*, 1709. Pangolagrass was grown on a humic latosol at 650 m elevation in an area of 170 cm average annual rainfall with relatively dry summers. Five levels of N from 0-640 kg/ha/yr were applied as $(NH_4)_2SO_4$ over a 2-yr period. Average annual dry matter (DM) yields ranged from 3780 kg (control) to 18,000 kg/ha, and response to succeeding increments of N ranged from 30 units of DM/unit of N for the first increment (160 kg) down to 10 units for the 480-640 kg increment. Yields were depressed when average night temperatures were ≤ 15 °C and during dry periods, but yields were significantly increased by fertilization even during these periods. Crude protein levels were influenced only slightly by low rates of fertilization but were raised by the higher N rates to levels sufficient to insure efficient utilization by livestock. Recovery of applied N increased from 36% for the first increment to 64% for the third increment, with a somewhat lower recovery for the final increment. Soil pH was reduced by 0.10-0.15 units/ton of $(NH_4)_2SO_4$ applied. Liming the soil raised pH from 5.6 to 6.3 but did not influence yields of DM or crude protein. Critical levels for potash sufficiency were established at 0.11 meq/100 g of soil or 1.0% of the dry forage.

125 Plant Responses to Iron, Leaching and Time After Liming a Virgin Alluvial Entisol from Eastern Costa Rica. M. I. Zantua and W. G. Blue (Univ. Florida, Gainesville). *Soil Crop Sci. Soc. Fla., Proc. 31*, 165-9 (1971). *FA 6*, 317. Yields of pangolagrass (*Digitaria decumbens* Stent.) and millet (*Pennisetum glaucum* L.) on an alluvial entisol in the greenhouse were significantly reduced by liming at 5 and 10 tons/ha. Foliar application of Fe-EDTA did not alleviate the depressed growth due to liming of millet and pangolagrass. However, leaching of the unlimed and limed soils increased growth of pangolagrass 80 and 27%, respectively, over the control (unleached, unlimed soil). Pangolagrass yield from the leached, limed soil was almost 5 times that from the unleached, limed soil. Since large amounts of Ca were leached both from the limed and unlimed soils, excessive salts may have contributed to the yield depression or some toxic organic substance may have been produced in the soil. It was also observed that the detrimental effect of lime and the increased growth through leaching were diminished with time. Phosphorus availability was not affected by liming as measured by P concentrations in millet, pangolagrass, and tomato. Calcium, Mg, K, Al, and micronutrients, other than Mn, in pangolagrass were not reduced by the addition of lime. Though the Mn concentration was significantly reduced, its concentration was above the critical level even at the highest lime rate.

VENEZUELA

126 Effect of Late Fertilization with Nitrogen on the Nutritive Value of Pangolagrass (*Digitaria decumbens*). E. Chacon (Univ. Central Venezuela, Maracay, Venezuela), S. Rodriguez-Carrasquel and C. F. Chicco. *Agron. Trop. (Maracay, Venez.) 21* (6), 503-9 (1971) (Span). *FA 5*, 1361. The effect of N fertilization (urea and ammonium sulfate, 63 kg N/ha) on yield, chemical composition, and *in vivo* and *in vitro* digestibility of mature pangolagrass (*Digitaria decumbens*) was determined at the end of the rainy season. Four 100 m^2 plots/treatment were harvested at 35 and 70 days after N application, and the grass was sun dried. The *in vivo* digestibility with total fecal collection was measured with six wethers/treatment. Significant yield differences ($P<0.05$) were found due to N fertilization and cutting time. Fertilization did not alter the chemical composition, while the cutting time had a significant ($P<0.01$) effect upon the lignin content. No significant differences due to treatment effects were registered for voluntary intake, *in vivo* organic matter, cellulose and crude protein digestibility and *in vitro* dry matter digestion.

127 Effect of Nitrogen Fertilization on Yield, Consumption, and Digestibility of Pangola Hay (*Digitaria decumbens* Stent.). C. F. Chicco, S. Rodriquez C., and C. E. Fuenmayor (Cent. Agron. Invest., Maracay, Venezuela). *Agron. Trop. (Maracay, Venez.) 21* (3), 215-27 (1971) (Span). *FA 5*, 610. The effect

of N fertilization on yield, chemical composition, digestibility, and rates of digestion *in vitro* and *in vivo* was determined on Pangolagrass. The N treatments were 0, 200, and 400 kg/ha of $(NH_4)_2SO_4$ applied on 2500 m^2 plots with four replications. Hay was harvested 60 days after fertilization. Digestibility of the hay was measured with four wethers/treatment, fed *ad libitum* and with total fecal and urinary collection. The rate of digestion of the cellulose *in vivo* was measured with two wethers/treatment with permanent fistulas, using the nylon bag technique. Measurements were made for 12, 24, and 48 hr with hays from the different treatments as substrate. Hay yields were increased significantly by the N treatments [5594, 6498, and 7815 kg/ha for 0, 200, and 400 kg/ha of $(NH_4)_2SO_4$]. No significant differences were obtained for effect of N level on intake, digestibility of dry matter, or digestibility of cellulose. Protein digestibility increased significantly (36.3, 42.6, and 46.2%). Rate of cellulose digestion *in vitro* also was significantly increased by N fertilization.

128 Foliar Interactions of N and P in *Digitaria decumbens*. R. Mundarain and J. F. Pereira. *Oriente Agropecuar., Venezuela 1* (2), 109-24 (1969) (Span). *Trop. Abstr. 26*, 1731. All combinations of 0-60-120-180 kg N (as urea) and 0-30-60-90 kg P (as triple superphosphate) were applied to plots of a pangola pasture in northeastern Venezuela. The grass was cut after 45 days at a height of 10 cm. Dry-matter yields, total N uptake, and total P uptake showed little or no effect from N without P or P without N. There was, however, a considerable N x P interaction, maximum values of 4550, 80, and 8.5 kg, respectively, being attained at maximum or near-maximum rates of both fertilizers. The N content of the dry matter increased with N rates and was not affected by P; the P content increased with both N and P rates. A graphical method was used to determine economically optimum fertilizer rates.

VIRGIN ISLANDS

129 Effect of Nitrogen Fertilization and Plant Spacing on Yield and Composition of Napiergrass in the Dry Tropics. A. J. Oakes. *Trop. Agr., Trinidad 44* (1), 77-82 (1967). *Trop Abstr. 22*, 712. A nitrogen fertilizer x spacing trial with napiergrass was conducted on a fertile clay soil in the U.S. Virgin Islands. Annual applications of 0, 140, 280, and 560 kg N/ha resulted in mean yields of dry matter and protein progressively increasing to 18.3 tons and 1.1 ton/ha, respectively. Yields in 1960, when the rainfall was 1260 mm, were much higher than those in 1961 with a rainfall of only 1087 mm. Protein content was about 8% and was hardly affected by fertilizer applications, confirming that napiergrass (like pangola- and guineagrass) depends on luxury consumption of N to increase its protein content appreciably. Spacings of 107 x 46, 107 x 69, and 107 x 91 cm did not result in different yields.

ASIA AND AUSTRALIA

AUSTRALIA

130 Nitrogen in Tropical Pastures. *Rur. Res. CSIRO 65*, 32-5 (1969). *Trop. Abstr. 26*, 964. Experiments in the tropical part of Australia showed that rhodesgrass is a strong competitor for soil-N. Townsville lucerne took up a much greater part of the available N when grown alone than when grown in association with rhodesgrass. Analyses of whole plants of rhodesgrass showed that the grass took up about 80% of the fertilizer-N and that uptake was directly proportional to the amount of fertilizer applied at rates up to 448 kg N/ha. Townsville lucerne and siratro took up a diminishing proportion of N from the soil as the plants grew older and symbiosis took over. By 15 weeks almost all of it was absorbed from the air. Very little transfer from legume to grass occurred. On present evidence, tropical legumes fix only about 224 kg N/ha each yr, but a grassy tropical pasture requires from 340 to 1100 kg N/ha for maximum yield.

131 Response of Tropical Grasses to Nitrogen Fertilizer. *Agr. Gaz. N. S. Wales 77* (8), 497-8 (1966). *Trop. Abstr. 22*, 112. In a trial conducted in New South Wales, plots of six tropical grasses during the growing season received 0, 84, 168, 336, or 672 kg N/ha in three equal applications, plus a basal dressing of 100 kg P_2O_5 and 150 kg K_2O/ha. Yields increased with increasing N rates. The highest level of N doubled the yield of *Setaria sphacelata*, pangolagrass (*Digitaria decumbens*), and rhodesgrass (*Chloris gayana*), and increased yields of *Paspalum plicatulum* and elephantgrass (*Pennisetum purpureum*) by only 83 and 33%, respectively. *Paspalum dilatatum* reached a maximum yield at a rate of 172 kg N/ha; this maximum was 50% above that of the control plots. The utilization of N was most efficient at 86 kg N/ha, but protein levels increased substantially with higher N applications. Autumn conditions reduced protein at all N levels to values as low as 4%.

132 Effect of Phosphorus on the Growth, Chemical Composition, and Critical Phosphorus Percentages of Some Tropical Pasture Grasses. C. S. Andrew (Cunningham Lab., St. Lucia, Queensland) and M. F. Robins. *Aust. J. Agr. Res. 22* (5), 693-706 (1971). *FA 5*, 456. Nine tropical pasture grasses were grown in pots of a P-deficient solodic soil with varying additions of P. Growth responses and chemical composition of the plant tops were recorded and critical percentages of P were established. All species responded to P addition; *Melinus minutiflora* was the most responsive and *Pennisetum clandestinum* the least responsive species. Critical percentages of P in the tops of *Melinus minutiflora, Cenchrus ciliaris, Paspalum dilatatum, Panicum maximum, Chloris gayana, Sorghum almum, Setaria anceps, Digitaria decumbens*, and *Pennisetum clandestinum* sampled at the immediate preflowering stage of growth were 0.18, 0.25, 0.25, 0.20, 0.22, 0.20, 0.21, 0.16, and 0.22% respectively of the dry matter. Phosphate applications decreased the concentration of plant K, had no significant effect on Ca, increased Mg in most species, and in four species

increased Na. The increases in Mg and Na are considered to result in part from reduced K uptake and the plant's ability to preserve cation balance. Three species, *C. gayana, P. maximum,* and *D. decumbens*, had relatively high concentrations of Na (58, 46, and 46% of total cations respectively). In contrast *S. anceps* had a relatively high concentration of K (56% of total cations) and low Na (7%). Phosphate applications decreased the concentration of N, and had little effect on Cl.

133 Comparative Responses to Manganese Excess of Eight Tropical and Four Temperate Pasture Legume Species. C. S. Andrew and M. P. Hegarty. *Aust. J. Agr. Res. 20* (4), 687-96 (1969). *Trop. Abstr. 25*, 636. In Queensland, pasture legumes were grown in water culture and their response to excess Mn was determined by comparing relative dry matter production (tops and roots), Mn, Ca, and N percentages in the dry matter. The tropical legumes as a group were as much affected by excess Mn as the temperate legumes. There were varying degrees of tolerance within each group. The relative tolerance of species depends in part on retention of Mn within the root system. Manganese treatments had little effect on the Ca and N concentrations in the dry matter (tops) of most species. Toxicity-threshold Mn values in the dry matter of the tops obtained in this investigation included: *Centrosema pubescens* 1600, *Stylosanthes humilis* 1140, *Phaseolus atropurpureus* 810, and *Glycine javanica* 560 ppm.

134 Effect of Aluminium on the Growth and Chemical Composition of Some Tropical and Temperate Pasture Legumes. C. S. Andrew, A. D. Johnson, and R. L. Sandland. *Aust. J. Agr. Res. 24,* 325-39 (1973). The effects of Al (0, 0.5, 1.0, 2.0 ppm) on the dry matter production (tops and roots) and chemical composition of five tropical and six temperate pasture legumes grown in a culture solution containing 2 ppm P were ascertained. The tolerances of the tropical species to Al were in the order *Desmodium uncinatum=Macroptilium lathyroides= Lotononis bainesii=Stylosanthes humilis≫ Glycine wightii>Medicago sativa*,and temperate species in the order *Trifolium rueppellianum=Trifolium semipilosum>Trifolium repens ≫ Medicago scutellata =Medicago truncatula =Medicago sativa*. In the tolerant species the yield of plant material from the 0.5 ppm Al treatment was greater than from the control. The top:root weight ratios of the tolerant species were unaffected by treatment; the ratios of the sensitive species were reduced. The effects of Al treatment on Al, N, P, K, Ca, Mg, and Na concentrations in the plants are given. The principal nutrients to be affected were Ca and P. Aluminum treatment reduced the Ca concentrations in the tops of all species and there were reciprocal relationships between Ca, Mg, and K concentrations. In the sensitive species Al treatment reduced P in the plant tops and roots; in some of the tolerant species the intermediate Al treatment increased the P concentration in the plant tops; however, the high Al treatment reduced the P concentration.

135 Effect of Potassium on the Growth and Chemical Composition of Some Pasture Legumes. III. Deficiency Symptoms of 10 Tropical Pasture Legumes. C. S. Andrew and W.H.J. Pieters. *Tech. Paper, Div. Trop. Pastures 5,* 2-11 (1970). *Trop. Abstr. 26*, 378. Foliar symptoms of K deficiency in 10 pasture legumes, grown in the tropical and subtropical regions of Australia are described in detail. The leaf levels of, among others, *Phaseolus, Desmodium, Stylosanthes,* and *Centrosema* species varied from 1.00 to 1.04% and from 0.29 to 0.57% K for healthy and deficient plants, respectively. Some characteristics, similar for all species are discussed.

136 The Effect of Potassium on the Growth and Chemical Composition of Some Tropical and Temperate Pasture Legumes. I. Growth and Critical Percentages of Potassium. II. Potassium, Calcium, Magnesium, Sodium, Nitrogen, Phosphorus, and Chloride. C. S. Andrew and M. F. Robins. *Aust. J. Agr. Res. 20* (6), 999-1007, 1009-21 (1969). *Trop. Abstr. 25*, 1915. Greenhouse experiments in Queensland, Australia, showed, among others, that the critical percentage of K in the tops of *Phaseolus atropurpureum* sampled at the immediate preflowering stage was 0.75 in the dry matter. Potassium at low rates gave large increases in growth, but had little effect on the plant K concentration. At medium to high rates, K concentration increased in the plant tissue. Potassium treatment, generally, caused decreases in Ca, Mg, and Na in the plant tissue. In general, KCl applications had no effect on plant N concentration, but increased the concentration of Cl and decreased that of P.

137 Phosphate Response of Mixed Swards at Mt. Cotton, Southeastern Queensland. C. G. Blunt and L. R. Humphreys. *Aust. J. Exp. Agr. Anim. Husb. 10* (45). 431-41 (1970). *Trop. Abstr. 26*, 1736. In southern Queensland, the grass *Setaria sphacelata* was grown in mixtures with one pasture legume out of four on plots which received 0, 11, 22, 45, or 90 kg P/ha in addition to a uniform basic fertilizer dressing; swards were cut 2, 3, 4, and 5 months after sowing Phosphorus levels beyond which no yield increase was obtained were 11 kg/ha for *Lotononis bainesii*, 22 kg/ha for volunteer grasses and sedges, and 45 kg/ha for *S sphacelata*; *Desmodium intortum, Stylosanthes guyanensis,* and *Phaseolus atropurpureus* continued to respond at 90 kg P/ha. An increase in P fertilizer rate resulted in lower N concentrations in nonlegumes, in higher P concentrations in all species, and in higher N yields of legumes/kg of P applied.

138 The Effect of Topdressed Superphosphate on the Yield and Botanical Composition of a *Stylosanthes guyanensis* Pasture. R. C. Bruce (Queensland Dep. Primary Ind., Brisbane, Australia). *Trop. Grassl. 6* (2), 135-40 (1972). *Trop. Abstr. 28*, 1167. A *Stylosanthes guyanensis* pasture in N. Queensland was topdressed with superphosphate at 0, 250, 375, 500, or 625 kg/ha and dry matter yields measured over a period of three successive growing seasons. Total dry matter yields were increased by superphosphate at each harvest. Highest yields and most desirable composition were obtained after application of superphosphate at 500 and 625 kg/ha. The initial response was by the legume, but at later harvests the grasses also responded. Soil N analyses failed to detect any increase in total soil N as a result of fertilizer treatment but available P analyses showed a decline in P status with time.

139 Leaching and Residual Value of Superphosphate and Rock Phosphate under High Rainfall Conditions. R. C. Bruce. *Queensl. J. Agr. Anim. Sci. 25* (1-2), 77-9 (1968). *Trop. Abstr. 23*, 2304. Superphosphate and rock phosphate at rates up to 225 kg P_2O_5/ha were applied at establishment of a pasture on a medium-textured alluvial soil with a pH of 5 in northern Queensland (Australia). The 0-10, 10-20, and 20-30 cm soil layers were analyzed for P extractable with dilute acid 3 yr after the fertilizer application; during this period the field had received about 12,500 mm rainfall. The results showed that even under these high-rainfall conditions superphosphate was not more mobile in the soil than rock phosphate, appreciable movement to deeper soil layers and an appreciable residue of

available P resulting only from the highest rates of P fertilizers.

140 Correlation of Soil Phosphorus Analyses with Response of Tropical Pastures to Superphosphate on Some North Queensland Soils. R. C. Bruce and I. J. Bruce (Dep. Primary Ind., Brisbane, Australia). *Aust. J. Exp. Agr. Anim. Husb. 12* (2), 188-94 (1972). *CA 77*, 33404. Soil analyses methods were correlated with the responses to superphosphate obtained in 21 pasture field experiments on the wet tropical coast of north Queensland. The *r* values for the correlation of percent yield with soil test were high enough for the Kerr-von Stieglitz and Colwell methods to suggest that these would be useful for predictive purposes. To separate soils into responsive and nonresponsive groups an arbitrary percent yield value (for example, 90%) was usually taken and the corresponding soil test value read as a critical value; 90% of the asymptotic maximum of the fitted curves corresponded to 17.5 ppm P for the Kerr-von Stieglitz method and 20 ppm P for the Colwell method. The failure of the Bray P^2 method to correlate with percent yield appeared to be due to its underestimation of the available P content of the soils which were derived wholly or partially from basaltic parent material. This method gave values approximately half those obtained by the other methods for these soils.

141 Botanical Changes Following Application of Fertilizer and Seed to Run-Down Paspalum, Kikuyu, and Matgrass Pastures on a Scrub Soil at Maleny, Southeast Queensland. W. W. Bryan. *Trop. Grassl. 1* (2), 167-70 (1967). *Trop. Abstr. 23*, 1212. Two grazed run-down pasture fields in southeastern Queensland were oversown with *Trifolium repens*. After 14 months, a field originally containing about 40% *Paspalum dilatatum*, 40% *Pennisetum clandestinum* and 15% *Axonopus affinis* had 23% clover where no fertilizer had been applied, 41% clover where PCaMo fertilizer had been applied. The introduction of clover resulted in a reduction of the proportion of *P. dilatatum* by an amount equal to the clover percentage, and left the proportion of *P. clandestinum* unchanged; *A. affinis* was reduced to 8%. Similar effects were observed in a field originally containing 20% *P. dilatatum* and 80% *P. clandestinum*.

142 Value of Nauru Rock Phosphate as a Source of Phosphorus for Some Tropical Pasture Legumes. W. W. Bryan and C. S. Andrew (CSIRO, St. Lucia, Australia). *Aust. J. Exp. Agr. Anim. Husb. 11* (52), 532-5 (1971). *FA 5*, 1383. Using soils known to be grossly deficient in P, and with a basal dressing of S and other deficient nutrients plants were grown in pots and in the field with single superphosphate or Nauru rock phosphate. The plants fell into two groups, those that gave moderate yield responses to rock phosphate as compared with superphosphate (*Lotononis bainesii, Stylosanthes guyanensis, Centrosema pubescens, Indigofera spicata*, and *Medicago sativa*) and those whose response to rock phosphate was poor (*Desmodium uncinatum* and *Phaseolus lathyroides*). In no case was the response to rock phosphate as good as that to superphosphate, even when twice as much P, in the form of rock phosphate, was applied. The residual value of rock phosphate was low with *Desmodium*, high with *Lotononis*, but never as high as that of superphosphate.

143 Response of a Matgrass-Paspalum Sward to Fertilizer Application. G. J. Cassidy. *Trop. Grassl. 5* (1), 11-22 (1971). *Trop. Abstr. 26*, 2843. Nitrogen, applied at 224 kg/ha to a paspalum (*Paspalum dilatatum*), matgrass (*Axonopus affinis*) and white clover (*Trifolium repens*) pasture at Beachmere (southeastern Queensland, Australia), over two successive growing seasons, increased the dry matter yield of total pasture from 5006 to 9688 kg/ha/yr. Paspalum, comprising 3.9% of the groundcover, was the main contributor to this increase through a sixfold increase in yield. The yield of matgrass was not increased by applied N, nor was its groundcover of 94% decreased. The maximum growth rate of paspalum was increased from 7.8 kg to 56 kg/ha/day during the main growing season.

144 Factors Affecting the Response to Nitrogen of Temperate and Tropical Grasses. R. L. Colman (Univ. New England, Australia). *J. Aust. Inst. Agr. Sci. 38* (3), 225-6 (1972). *FA 6*, 652. Three greenhouse and two field studies were conducted at Armidale, New South Wales, to measure the effects of temperature, moisture supply, defoliation, N rate, and frequency of N application on the comparative growth and N uptake of tropical and temperate grasses. The tropical grasses were *Digitaria magroglossa* and *Paspalum dilatatum* and the temperate grasses *Lolium perenne* and *Phalaris tuberosa*. Temperature treatments in the greenhouse were 13-24°-T1 and 24-35°-T2 for tropical grasses. A wide range of N rates (from nil to 874 kg/ha) were applied at frequencies ranging from every 16 weeks to twice weekly. Herbage production was measured using conventional techniques. In the greenhouse, yields of the tropical species were greater at T2 than at T1. At T1, the tropical grasses produced a similar level of herbage; at T2, tropical grasses produced nearly twice the yield of the temperate grasses. At comparable greenhouse temperatures, the four grasses used similar amounts of water. However, water-use efficiency of the tropical grasses was almost twice that of the temperate species. In the field, growth of the tropical grasses was reduced less by restricted moisture supply than was that of the temperate species. Response to N was determined largely by moisture and temperature. Tropical grasses grown in the greenhouse at T2 responded most to N; temperate and tropical grasses responded to a similar degree when grown at T1. Seasonal differences in N responses were directly related to the potential growth of the grasses under the climatic conditions prevailing. Nitrogen did not improve herbage yield when other environmental factors were more limiting. The response to N declined with increasing frequency of cutting. The proportional reduction in yield due to cutting was less when N was applied than without N. Percent N content of the tropical grasses was consistently less than that of the temperate species. Further, the increase in N percentage as a result of N application was greater for the temperate than the tropical species.

145 Future Use of Nitrogen Fertilizers on Pastures and Crops in Subtropical New South Wales. R. L. Colman. *J. Aust. Inst. Agr. Sci. 36* (3), 224-32 (1970). *Trop. Abstr. 26*, 1466. In New South Wales, the most likely use of N fertilizer over the next 10 yr will be: (a) spring and/or autumn application to tropical legume-grass pastures, such as *Glycine javanica–Pennisetum clandestinum* pastures; (b) application to tropical grass pastures for intensive production; and (c) use on fodder crops grown as a supplement to grass dominant unimproved pasture, tropical legume grass pastures or intensively managed improved grass pastures either for grazing or conservation. A leguminous summer forage crop is *Dolichos lablab*, and winter forage crops are *Vicia faba* and oats. These pasture systems apply mainly to the dairying industry, and possibly offer a solution to the problem of low farm incomes.

146 Changes in Soil Nitrogen Following Different

Establishment Procedures for Townsville Stylo on a Solodic Soil in Northeastern Queensland. B. J. Crack (Div. Soils, CSIRO, Townsville, Australia). *Aust. J. Exp. Agr. Anim. Husb. 12* (56), 274-80 (1972). *CA 77*, 87068. Where Townsville stylo was sown into existing native grassland, the effect on soil N was slow. However, where the areas were fertilized with superphosphate, accelerated changes occurred in soil N. The soil N increase and seasonal NO_3^- accumulation assisted grass growth at the onset of the wet season and could influence subsequent changes in pasture composition. On plots sown to Townsville stylo, the legume content and total plant N yields increased in each season, being much greater for plots fertilized with superphosphate than for the unfertilized ones. No significant soil changes occurred in the 1st 2 years, but over a 4-yr period, significant increases in soil total N occurred in legume plots. In an experiment, an area of Lansdown sandy loam, where well-established Townsville stylo was grazed previously, was cultivated and sown to Townsville stylo and the grass *Urochloa mosambicensis* on plots treated with varying amounts of superphosphate. The plots were ungrazed, but mowed with removal of plant material. Where Townsville stylo and the grass were sown on clean, cultivated land, legume establishment was satisfactory in the first season and comprised approximately 70% of dry matter yield. Although legume content varied from yr to yr, it did not fall below 50%. In general, plant N yields increased with increasing rates of P throughout the experiment.

147 Establishment of Legumes in Pasture of Savanna Woodland in North Queensland. R. W. Downes. *Queensl. J. Agr. Anim. Sci. 24* (1), 23-9 (1967). *Trop. Abstr. 23*, 102. Six perennial and two annual legumes were sown by broadcasting or drilling with or without application of P fertilizer, in the indigenous grass pasture of savanna woodland in North Queensland (Australia). Although satisfactory results were obtained with broadcasting on unfertilized land, the best establishment resulted from drilling seed on land fertilized with a fertilizer containing 10% P_2O_5 and 24% CaO at a rate of 255 kg/ha. The annual legumes *Dolichos biflorus* and *Stylosanthes humilis* proved to be superior to the six perennial legumes with respect to stand and vigor in the season of establishment. To control undue competition from the indigenous grasses, frequent burning, early in the dry season, may prove advantageous for proper establishment of these legumes.

148 Beef Production from Nitrogen Fertilized Pangolagrass (*Digitaria decumbens*) on the Coastal Lowlands of Southern Queensland. T. R. Evans. *Aust. J. Exp. Agr. Anim Husb. 9* (38), 282-6 (1969). *Trop. Abstr. 24*, 2771. In Queensland, animal production from *Digitaria decumbens* fertilized with 450 and 900 kg N/ha was measured during 1965-67. Yearling Hereford heifers were used at a mean stocking rate of 7.5 beasts/ha. A mean annual production of 1275 and 1360 kg/ha was obtained from 450 and 900 kg N/ha, respectively. Although there was 20-30% greater dry matter production containing approximately 3.5% more crude protein from the higher N application for most periods of the yr, this had little effect on total animal production. The highest rates of liveweight gain were recorded during Sept.-Dec. coincident with the highest crude protein and P-levels in plant material

149 The Effects of Superphosphate on the Growth and Development of Townsville Stylo (*Stylosanthes humilis*) in Pure Ungrazed Swards at Katherine, N. T. M. J. Fisher. *Aust. J. Exp. Agr. Anim. Husb. 10* (47), 716-24 (1970). *Trop. Abstr. 26*, 1743. The effects of four levels of superphosphate (0, 125, 251, and 502 kg/ha) on the growth and development of ungrazed *Stylosanthes humilis* in pure swards were examined on virgin Tippera clay loam in northern Australia. Superphosphate encouraged root exploitation of the soil volume, but P deficient swards were more resistant to drought. The maximum recovery of P was 20, 14, and 14%, respectively, when 125, 251, and 502 kg/ha superphosphate was applied. Loss of 31% dry matter, 34% N, and 44% P in the 8 weeks following maximum yield was concluded to be due to translocation to the root system. Even with 502 kg/ha superphosphate the P content of standing material was below the critical percentage quoted in the literature as indicating P sufficiency.

150 Effect of Fertilizer Nitrogen on a Dense Sward of Kikuyu, Paspalum and Carpet Grass. I. Botanical Composition, Growth, and Nitrogen Uptake. J. A. Gartner. *Queensl. J. Agr. Anim. Sci. 26* (1), 21-33 (1969). *Trop. Abstr. 24*, 2772. In northern Queensland, *Paspalum dilatatum* was sown when rain-forest areas were felled. Later it was overplanted with kikuyu (*Pennisetum clandestinum*), which established extremely well. However, with time carpetgrass (*Axonopus affinis*) began to invade Approximately 170 kg/ha N was the minimum level to effect a reversion to dominance by the superior species, kikuyu and paspalum. More than 225 kg/ha N was required to develop kikuyu dominance. Dry matter and N yield responses to the application of 0, 55, 110, 220, and 440 kg/ha N were linear in each of the 3 yr of measurement. Maximum annual dry-matter yields ranged from approximately 10,000 to 12,300 kg/ha. Nitrogen recovery improved from 36 to 52% in the final yr. Lower levels of exchangeable K were recorded in the soil under the 220 and 440 kg/ha N treatments.

151 Effect of Fertilizer Nitrogen on a Dense Sward of Kikuyu Paspalum and Carpetgrass. II. Interactions with Phosphorus and Potassium. J. A. Gartner. *Queensl. J. Agr. Anim. Sci. 26* (3), 365-72 (1970). *Trop. Abstr. 26*, 677. On the Atherton Tableland in Queensland, superphosphate and muriate of potash were applied in the $N:P_2O_5:K_2O$ ratio 2:1:2 to plots of *Pennisetum clandestinum* (kikuyu)–*Paspalum dilatatum*-*axonopus compressus* (carpetgrass) which had been fertilized with urea at rates up to 448 kg N/ha/yr for the previous 3 yr. The application of K increased dry-matter yield by 31% at 448 kg N/ha and 10% at 224 kg N/ha. It did not affect yield at 112 kg N/ha. These responses are linked with levels of available K in the soil at the commencement of the experiment and the N:P ratio in the herbage. The application of P did not influence yield to any great extent.

152 The Effects of Different Rates of Fertilizer Nitrogen on the Growth, Nitrogen Uptake and Botanical Composition of Tropical Grass Swards. J. A. Gartner (Dep. Prim. Ind., Atherton, Australia). *Proc. Int. Grassl. Congr., 10th*, pp. 223-7 (1966). On the Atherton Tableland of Queensland, linear yield responses to N fertilizer up to levels of 400 lb N/acre/yr were recorded in pastures based on green panicgrass (*Panicum maximum* variety *trichoglume*) or kikuyugrass (*Pennisetum clandestinum*). High levels of N induced a K deficiency in a kikuyugrass sward. Urea was found to be an inferior source of N, compared with ammonium sulfate, sodium nitrate, and ammonium nitrate. The higher rates of fertilizer maintained, or renewed, a desirable botanical composition of swards of both species.

153 Fertilizer Response of Green Panic on the Atherton Tableland, Queensland. J. A. Gartner. *Queensl. J. Agr. Anim.*

Sci. 24 (3-4), 245-52 (1967). *Trop. Abstr. 23*, 2307. A 2-yr fertilizer trial with *Panicum maximum* variety *trichoglume* in Queensland in the 1st yr showed a linear response from 7 to 11 tons dry matter/ha to single dressings of 0, 52, 105, and 157 kg N/ha. In the 2nd yr these N treatments increased the yield from 5 to 7.8 tons/ha. Concurrent supply of superphosphate at 28, 55, and 82 kg P_2O_5/ha did not affect production, irrespective of yr. The mean response in summer was some four times that in the cooler period when differential effects appeared absent. Data for both yr suggested maximum N efficiency of some 40 kg dry matter/kg N at a rate of 52.5 kg N/ha compared with 29 and 20 kg at the intermediate and higher level, respectively. Invasion by undesirable species was suppressed at higher N levels.

154 Effects of Fertilizer Nitrogen on a Dense Sward of Kikuyu, Paspalum and Carpetgrass. III. Nitrogen Source. J. A. Gartner and M. L. Everett (Queensland Dep. Prim. Ind., Brisbane, Australia). *Queensl. J. Agr. Anim. Sci. 27* (1), 73-87 (1970). *FA 4*, 316. Four sources of fertilizer N (ammonium nitrate, ammonium sulfate, sodium nitrate, and urea) were tested for 1 yr on a pure kikuyu sward at Millaa at rates of 0, 50, 100, 200, and 400 lb N/acre/yr. Cattle grazed the sward before trimming after harvesting The annual dry matter and annual N yield responses to N rate were linear for all sources. At some harvests there were significant interactions between source and rate for dry matter yield and N concentration and N yield. Generally, at 50 and 100 lb N/acre there were no differences between sources, but at 400 lb N/acre, ammonium nitrate produced 3320 lb more dry matter/acre than urea. Nitrogen recovery from ammonium nitrate was 92% as against 58% for urea.

155 Copper, Zinc, and Molybdenum Fertilizers for New Land Crops and Pastures—1969. J. W. Gartrell and R. N. Glencross. *J Agr., W. Aust. 9* (11), 517-21 (1968). *FA 2*, 563. General recommendations for the use of fertilizers, including those containing micronutrients, are presented for each of 17 zones in Western Australia. The recommendations are based on 4 yr of research. Recommendations are in terms of rate of application for crop and pasture land using different superphosphate fertilizers containing two levels each of Cu, Mo, and Zn. For some areas these fertilizers must be supplemented with additional amounts of these or other micronutrients

156 Effect of Method of Establishment of Townsville Stylo and Application of Superphosphate on the Growth of Steers. T. G. Graham and B. G. Mayer (Queensland Dep. Prim. Ind., Brisbane, Australia). *Queensl. J. Agr. Anim. Sci. 29* (4), 289-96 (1972). *FA 6*, 1410. In a grazing experiment in central coastal Queensland two methods of introducing Townsville stylo (*Stylosanthes humilis*) into native black speargrass (*Heteropogon contortus*) pasture were compared. Both allowed the stocking rate to be increased from a normal one beast/8 acres to one beast/4 acres without impairing steer growth rate. When superphosphate was applied steer growth rate was considerably improved. Two groups of Brahman cross steers each grazed the trial pastures for 2 yr and in both instances the steers from the superphosphate-treated paddocks with Townsville stylo were appreciably better grown and four times as many were finished for market at 2.5 yr of age. The levels of production achieved/acre over the 4 yr were 2.5 times that of native pasture, or 76 lb/acre as against 30 lb. The two areas of Townsville stylo not treated with superphosphate gave 57 lb and 56 lb/acre. There was no appreciable difference in production between introducing Townsville stylo by complete cultivation and introducing it by the contour strip method where only one-quarter of the area is disturbed. The latter was a far cheaper method.

157 Effects of Renovation and Nitrogen Fertilization on an Old Stand of Buffelgrass (*Cenchrus ciliaris*) in Subcoastal Central Queensland. B. Grof *et al. Queensl. J. Agr. Anim. Sci. 26* (3), 359-64 (1970). *Trop. Abstr. 26*, 671. In Queensland, the effect of urea at 125 kg/ha and cultivation with disk harrows was studied, alone and in combination, as a means of restoring vigor to an old buffelgrass pasture. Unsuccessful attempts were also made to introduce a fertility building legume, initially *Glycine javanica*, subsequently *Medicago sativa*. Rainfall over the 2 yr was below average. Nitrogen with or without disking resulted in major increases in dry-matter yield. Disking alone, prior to the dry autumn 1961, resulted in a significant depression in yield. Forage quality was improved by both N application and disking, but total crude protein yield was increased only by N treatment. Nitrogen recoveries were only in the order of 20%. Possible reasons for this are suggested.

158 Dry Matter Yields and Animal Production of Guineagrass (*Panicum maximum*) on the Humid Tropical Coast of North Queensland. B. Grof and W.A.T. Harding. *Trop. Grassl. 4* (1), 85-95 (1970). *Trop. Abstr. 26*, 370. In cutting and grazing experiments conducted in Queensland, Australia, dry-matter yields of 10 guineagrass varieties ranged from 15.7 to 26.9 tons/ha/yr. The most efficient N application was 140 kg/ha/yr, resulting in a yield increment of 38 kg dry matter/kg of N applied. A pasture mixture of guineagrass and *Centrosema pubescens* yielded 36% more liveweight gain than guineagrass only, and the application of 168 kg N/ha/yr yielded 41% more liveweight gain than the grass-legume mixture. Liveweight gains over 2 yr were 16% higher for rotationally grazed than for continuously grazed guineagrass.

159 The Influence of Potassium Supply on Competition Between *Nandi setaria* and Greenleaf *Desmodium*. R. L. Hall (CSIRO, Div. Trop. Pastures, St. Lucia, Australia). *Aust. J. Exp. Agr. Anim. Husb. 11* (51), 415-9 (1971). *Trop. Abstr. 27*, 869. A greenhouse experiment conducted in Queensland indicated that the yield of *Desmodium intortum* under conditions of low K supply, that is, where competition for nutrients could occur, was restricted by the presence of *Setaria anceps*. This effect was not observed either when K fertilizer was added to the system, or when competition for nutrients was prevented, which suggests that *S. anceps* was the more successful competitor for soil K.

160 Effect of Superphosphate on the Germination of Townsville Lucerne (*Stylosanthes humilis* H.B.K.). R. L. Harty. *Queensl. J. Agr. Anim. Sci. 24* (2), 235-6 (1967). *Trop. Abstr. 23*, 104. In view of the occurrence under field conditions of poor establishment of *Stylosanthes humilis* when it was sown simultaneously with an application of 125 kg superphosphate/ha, laboratory tests were conducted in Queensland on the germination of abraded seed of *S. humilis* in petri dishes as affected by the addition of superphosphate at rates equivalent to up to 3125 kg/ha. Germination was found to decline significantly above a superphosphate application rate equivalent to 125 kg/ha, and was completely inhibited by rates above 250 kg/ha. Germination in the field may therefore be adversely affected in the presence of superphosphate broadcast at a rate above 125 kg/ha.

161 Response of a Pangolagrass Pasture Near Darwin to the Wet Season Application of Nitrogen. Kay Hendy (Northern Terr. Adm., Darwin, Australia). *Trop. Grassl. 6* (1), 25-32 (1972). *FA 5*, 1363. The response of a pangolagrass pasture to N fertilizer at 0, 100, 200, 400, 600 lb N/acre in split applications during the wet season was measured near Darwin. There was a response in dry matter production up to the highest N level, but the differences in response occurred mainly during the early showers and not during the monsoonal rains of the wet season. Crude protein content and crude protein production/acre increased and the N recovery decreased with increasing levels of N fertilizer over the whole growing season. The P and K contents of the pasture were low.

162 Loss of Nitrogen from a Nitrogen-Fertilized Pasture. E. F. Henzell (Div. Trop. Pastures, CSIRO, St. Lucia, Australia). *J. Aust. Inst. Agr. Sci. 38* (4), 309-10 (1972). *CA 78*, 158274. Nitrogen accumulated at the rate of 121 kg/ha/yr in the surface soil and standing plant material in a pasture receiving 374 kg N/ha/yr. Of the N added as urea over a 4-yr period, 60% could not be accounted for in the cattle, the standing herbage, or the soil to a depth of 76 cm. Despite the poor recovery, it might be possible to build up a sufficient residual effect to reduce the rate of fertilization.

163 Recovery of Nitrogen from Four Fertilizers Applied to Rhodesgrass in Small Plots. E. F. Henzell (CSIRO, Div. Trop. Pastures, St. Lucia, Australia). *Aust. J. Exp. Agr. Anim. Husb. 11* (51), 420-30 (1971). *Trop. Abstr. 27*, 877. The response to N applied as $NaNO_3$, $(NH_4)_2SO_4$, urea, or ammonium nitrate-limestone at 56, 112, 224, or 448 kg N/ha/yr was measured over 7 yr in Queensland. The ranking order of mean yields of dry matter and N at fertilizer rates where rhodesgrass (*Chloris gayana*) remained dominant (224 and 448 kg) was: $NaNO_3$>ammonium nitrate-limestone>urea. $(NH_4)_2SO_4$ was about as effective as $NaNO_3$. The comparative efficiency of urea varied widely. Taking the weighted mean for the two higher rates over 7 yr, urea gave 87% of the N yield that $NaNO_3$ gave.

164 Sources of Nitrogen for Queensland Pastures. E. F. Henzell. *Trop. Grassl. 2* (1), 1-17 (1968). *Trop. Abstr. 23*, 2302. Quantitative estimates are given for the rates of the various processes constituting the N cycle of native grasslands and pastures in Queensland. Nitrogen deficiency is general; this is not due to an insufficient amount of total N in the soil but to slow mineralization. Removal of N by grazing animals is relatively unimportant. Research has shown the way to improve the N nutrition of pastures by interplanting with legumes; up to 340 kg N/ha/yr may be fixed by nodule bacteria. Fertilizer trials have demonstrated that responses of pasture growth and animal production to N fertilizers are usually too small to make fertilizer application profitable. Moreover, tropical grasses have a low feeding value even when their protein content is satisfactory.

165 Use of Nitrogenous Fertilizers on Subtropical Pastures in Queensland. E. F. Henzell. *J. Aust. Inst. Agr. Sci. 36* (3), 206-13 (1970). *Trop. Abstr. 26*, 1470. During the period 1964-65 to 1967-68 fertilizer use on pastures in Queensland increased by 51%/annum for straight N and 47% for mixtures; superphosphate showed a similar rate of increase. In 1967-68 about 1120 mt of N were applied to pastures. The increase has been due chiefly to a change in the proportion of sown pasture land receiving fertilizer. The present use of N on pastures is concentrated in the main dairying regions. The prospects for use of N in northern Queensland seem to be restricted to the dairy lands and possibly to beef production from irrigated pangolagrass (*Digitaria decumbens*). The price of N and the trends overseas are discussed.

166 Variation in Leaf-Nitrogen Concentration in Two Tropical Grasses. E. F. Henzell and D. J. Oxenham (Cunningham Lab., CSIRO, St. Lucia, Australia). *Commun. Soil Sci. Plant Anal. 4* (2), 155-61 (1973). *FA 6*, 1222. Variation in leaf N concentration was studied in pot and field experiments with the tropical grasses Nandi setaria (*Setaria anceps* cultivar Nandi) and Biloela buffel (*Cenchrus ciliaris* cultivar Biloela). The % N of samples of 20 leaf blades from grazed fields up to 2.7 ha in area had a relative standard deviation of less than 10%. The variation in leaf N (%) between different-sized tillers on the same plants (tussocks) was statistically significant but relatively small. The results showed that accidental selection of the blade from the leaf, one older or younger than the usual index leaf, (the youngest with the ligule exposed) is unlikely to bias leaf N seriously.

167 Studies on the Growth of *Leucaena leucocephala*. I. Effect of Clean Weeding and Nitrogen Fertilizer on Early Establishment. G. D. Hill (Dep. Agron., Univ. W. Australia, Nedlands). *Papua New Guinea Agr. J. 22* (1), 29-30 (1970). *Trop. Abstr. 27*, 638. In an experiment conducted in New Britain, *L. leucocephala* was sown with a dressing of 0, 34, or 68 kg of N/ha, the plots being weeded or left unweeded. Significant responses to weeding and N were obtained. On weeded plots there was no increase in production from N applications. Nodulation of N treated plots was not affected by the levels of N used.

168 Getting Started with Tropical Pastures. K. Loftus Hills. *World Farming 12* (7), 6-8, 26, 28 (1970). *Trop. Abstr. 26*, 1997. Pasture establishment and management methods employed in southeastern and northeastern Queensland are discussed. Attention is paid to seedbed preparation, fertilizing, and grazing management. In the tropical coastal areas superphosphate is applied at seeding at 250-500 kg/ha, even on highly fertile rainforest soils. The legume *Centrosema pubescens*, in association with the grasses *Panicum maximum* or *Pennisetum purpureum* has been the mainstay of the cattle fattening industry in the more fertile high rainfall areas. On the poorer soils of the tropical coast, *Stylosanthes guyanensis* replaces *Centrosema pubescens* and the *Setaria* species, called nandi and kazungula, substitute for the taller tropical grasses. The legumes *Glycine javanica*, *Phaseolus purpureus*, and *Desmodium* species show promise in some drier areas.

169 Tropical Grasses; New Material for the Pasture Revolution. K. Loftus Hills. *World Farming 12* (4), 22-6 (1970). *Trop. Abstr. 26*, 1463. The introduction and establishment of tropical grasses in the tropical part of Queensland are described. Particular attention is paid to the grasses: *Melinis minutiflora*, *Digitaria decumbens*, *Brachiaria mutica*, *Panicum maximum*, *Paspalum commersonii*, *Setaria sphacelata*, *Pennisetum purpureum*, *Chloris gayana*, *Panicum coloratum*, *Sorghum almum*, and *Cenchrus ciliaris*. Experiments in the high-rainfall, subcoastal area showed that grass swards comprising mixed cultivars of *Panicum coloratum* produced 31,000 kg dry matter/ha annually when fertilized at 670 kg N/ha over the yr. *Setaria sphacelata* produced 27,000 kg/ha, *Panicum maximum* 22,000, and *Cenchrus ciliaris* 20,500 kg/ha under the same conditions.

170 Aerial Topdressing of Northern Hills Country. A. E. Hincks (Loxton, S. A.). *J. Agr. South Australia 72* (10), 391-4 (1969). *FA 2*, 1757. Three- to fivefold increases in sheep carrying capacity are achieved after 4-5 yr of superphosphate application to naturally occurring pasture in rough hill country. The growing season is 5-7 months, rainfall 12-26 in., and elevation 1000-2000 ft. The herbage consists of bromes, wild oats, and silvergrass for the annuals and bunch- and speargrass for the perennials. Without P the average carrying capacity is 0.4 dry sheep equivalents/acre. Superphosphate is applied at rates of 90-112 lb/acre/yr with the higher rate used on calcareous soils. Overseeding with 5 lb/acre of subterranean clover improves the pasture. Topdressing is best done in the autumn.

171 The Production and Persistence of Grazed Irrigated Pasture Mixtures in Southeastern Queensland. R. J. Jones *et al. Aust. J. Exp. Agr. Anim. Husb. 8* (31), 177-89 (1968). *Trop. Abstr. 23*, 1638. Five mixtures of tropical and temperate-zone grasses and legumes were compared in southeastern Queensland during 4 yr. The pastures were intermittently grazed and received overhead irrigation; 0, 250, or 750 kg urea/ha was supplied annually in addition to a basal dressing providing K, P, Ca, S, Mo, and Cu. Among the species that survived, the most successful ones were *Setaria sphacelata, Chloris gayana, Bromus unioloides,* and *Trifolium repens* cultivar Ladino; 3 *Paspalum* species could not compete with *S. sphacelata* whereas *C. gayana* was able to do so. Dry-matter yields increased during the trial period to around 28 ton/ha in the 4th yr when urea was applied at 750 kg/ha; the proportion of *T. repens* declined as more urea was applied.

172 Deep Sandy Soils in Cape York Peninsula, North Queensland. II. Plant Nutrient Status. R. K. Jones (Div. Trop. Past., CSIRO, Townsville, Australia). *Aust. J. Exp. Agr. Anim. Husb. 13* (60), 89-97 (1973). *CA 79*, 30868. The nutrient status of the deep siliceous sands which cover an extensive area in Cape York Peninsula were studied in glasshouse and field experiments. Using Townsville stylo (*Stylosanthes humilis*) as a test legume, the soils were found to be extremely deficient in P and S, and moderately so in Zn, Cu, and K. Responses to Mo were found on most of the eight soils tested in the glasshouse but these were not confirmed at the field site in either of the two growing seasons. There was little response to Ca (lime) in spite of the very low levels of total and exchangeable Ca in these soils. Suggested reasons for this are the known tolerance of tropical legumes to low Ca supply and the fact that exchangeable Ca, although low, represented a fairly high percentage of the total exchange capacity. Levels of total N in these soils were also very low and the native grasses were able to absorb only 15 kg N/ha in an entire growing season. Two samples of rock phosphate (from northwestern Queensland and Christmas Island) were found to be very poor alternatives to superphosphate, at least in the first season. In spite of the extreme infertility of these soils, very high levels of pasture production (>10,000 kg of Townsville stylo/ha) could be achieved in well-fertilized pastures.

173 Initial and Residual Effects of Superphosphate on a Townsville Lucerne Pasture in Northeastern Queensland. R. K. Jones. *Aust. J. Exp. Agr. Anim. Husb. 8* (34), 521-7 (1968). *Trop. Abstr. 24*, 854. In field experiments conducted over 3 yr in Queensland, a *Stylosanthes humilis* grass pasture on a solodic soil responded markedly, particularly in the grass component, to varying amounts of superphosphate. Applying all of 375 kg superphosphate/ha in the 1st yr resulted in a near-maximum yield increase of dry matter over the 3-yr period, but splitting this application in three equal annual dressings proved to be slightly advantageous with regard to total yields of N and P. Superphosphate had a good residual effect; it increased significantly the P, but not the N content, of both the legume and the grass. The relation between P content of the pasture and the yield of dry matter was examined and tentative critical P content values were established for diagnostic purposes.

174 Sulfur Deficiency of Dryland Lucerne in the Eastern Darling Downs of Queensland. R. M. Jones. *Aust. J. Exp. Agr. Anim. Husb. 10* (47), 749-54 (1970). *Trop. Abstr. 26*, 1748. In Australia experiments were conducted to study the P, Mo, and S requirements of lucerne swards. The soils at all sites were derived from basalt. The swards did not respond to P at any of the sites and responded to Mo at only one. Sulfur deficiency was more severe in late winter-early spring than in summer. Lucerne response to added S was not related to total soil S and only partly related to available soil S or water soluble soil sulfate. Five lucerne swards on black earths showed decreasing S deficiency with increasing soil depth and increasing soil salinity. On one site annual medics were more severely affected by S deficiency than was the deeper rooting lucerne.

175 The Comparative Rates of Phosphate Absorption by Eight Annual Pasture Species. J. Keay, E. F. Biddiscombe, and P. G. Ozanne (Western Australian Lab., Wembley, Aust.). *Aust. J. Agr. Res. 21* (1), 33-44 (1970). *FA 3*, 938. Phosphate flux into roots from soil increased with increase in applied phosphate in eight annual pasture species, except in lupins at higher levels of application where toxicity was pronounced. The rate of uptake decreased with time, the decrease being least in the clovers. The relationship between rate of uptake and level of applied phosphate was sigmoid for the legumes, less so for erodium and cape-weed, and nonsigmoid for the grasses. Marked differences among species were found in the distribution of absorbed phosphate. It is suggested that the observed differences among species in response to applied phosphate depend on physiological and anatomical characteristics, although the evidence from phosphate fluxes suggests that lupin had an ability to remove phosphate not possessed by other species.

176 Plant Nutrient Status of Soils of the Atherton Tableland, North Queensland. P. C. Kerridge, C. S. Andrew, and G. G. Murtha (Div. Trop. Pastures, CSIRO, St. Lucia, Aust.). *Aust. J. Exp. Agr. Anim. Husb. 12* (59), 618-27 (1972). *CA 78*, 96512. In pot experiments the nutrient requirements of pasture legumes (*Trifolium repens* and *Desmodium intortum*) were studied on the Atherton Tableland soils of North Queensland. Phosphorus was the most limiting nutrient for legume growth on all soils studied. Responses to P fertilization were highly inversely correlated with soil-available P (r = -0.78). Molybdenum was the next deficient nutrient; molybdenum response was correlated with total soil N (r = -0.46). Potassium response occurred in all granite soils and in the basalt and volcanic soils from the high-rainfall areas. There was no response to K in soils on metamorphic rocks. Response to K was correlated with rainfall (r = -0.61), exchangeable cations (r = -0.52), and pH (r = -0.46). Sulfur response was infrequent and of small magnitude. Except for the strong response of *T. repens* on the granite soil, responses to liming were not significant. Copper and Zn may be marginal for some plants.

177 The Influence of Nitrogen and Water on Pastures of Green Panic, Lucerne, and Glycine at Lawes, Southeastern Queensland. F. H. Kleinschmidt. *Aust. J. Exp. Agr. Anim. Husb.* 7 (28), 441-6 (1967). *Trop. Abstr. 23*, 530. The influence of N fertilizer and supplementary irrigation on pastures of *Panicum maximum* variety *trichoglume* alone or mixed with lucerne or *Glycine javanica* was studied in Queensland. The grass yield increased and that of legumes decreased when N was applied. Nitrogen fertilizer significantly increased the total dry matter and N yields from grass and grass + *G. javanica* swards but not from grass + lucerne swards. Lucerne was more productive than *G. javanica*. Inclusion of legumes in the sward increased the total yield of N. Without N fertilizer, lucerne and *G. javanica* increased N yields by 260 and 70 kg/ha/yr, respectively; most of this extra N was harvested in the legume.

178 Evaluation of Christmas Island C-Grade Phosphate as a Fertilizer on Some Soils in Southern New South Wales. J. Lipsett and C. H. Williams (CSIRO, Canberra, Australia). *Aust. J. Exp. Agr. Anim. Husb. 10* (47), 783-9 (1970). *FA 4*, 1731. Finely-ground calcined C-grade phosphate from Christmas Island was compared with other forms of phosphate as a source of P for plants. In the glasshouse there was little P uptake from Christmas Island phosphate at first harvests of subterranean clover and ryegrass, but uptake by both species increased at later harvests, both in absolute amount and relative to that from soluble phosphate. The availability of the calcined phosphate varied from soil to soil. In the field, pasture plants made appreciable use of the phosphate only in second or subsequent yr; mixtures of calcined C-grade phosphate with superphosphate (1:1) were more effective in the 1st yr on pasture than the C-grade phosphate alone, and produced similar responses to equivalent amounts of superphosphate.

179 Pangolagrass for Quick Feed. T. H. McCosker. *Queensl. Agr. J. 95* (12), 790-5 (1969). *Trop. Abstr. 25*, 2680. Pangolagrass (*Digitaria decumbens*) has spread to most of coastal Queensland. It is used to open up land hitherto regarded as wasteland, such as the wet, sandy, wallum, and poor clayey soils of old eroded cultivation paddocks. Pangolagrass is a summer growing perennial, which, under favorable conditions, produces large quantities of forage very rapidly. It has particularly palatable new growth, and is markedly successful as a producer of milk and meat. The growth of pangolagrass is described, as well as the climatic conditions needed for satisfactory growth. Pangolagrass is susceptible to frost. In addition, attention is paid to: establishment, fertilizers, management, productivity, and economics.

180 Effect of Time of Application of Superphosphate on Seasonal Yield of Dry Matter from Annual Pasture. A. A. McGowan (Cameron Lab., Werribee, Victoria, Aust.) and I. H. Cameron. *Aust. J. Exp. Agr. Anim. Husb. 12* (57), 392-5 (1972). *FA 6*, 1243. A subterranean clover (*Trifolium subterraneum*) annual grass pasture received an annual topdressing of superphosphate, at 125 kg/ha in a particular month, for each of the 12 months. In winter dry matter yield was increased by 350-1190 kg/ha when superphosphate was applied at any time of the yr. Winter yields were higher after application in January-May (mean 1570 kg/ha) than in October-December (mean 1190 kg/ha) or in June-July (mean 1230 kg/ha). In spring, the greatest increases in dry matter yield were from topdressing in August or September (1600 and 1210 kg/ha, respectively). Spring yields following application in other months were smaller but usually significantly greater than the yield of unfertilized pasture. The response to autumn application of superphosphate was much greater in winter than in spring.

181 Stocking Rate and the Superphosphate Requirements of Sown Pasture on an Acid Soil. K. D. McLachlan (CSIRO, Canberra). *Aust. J. Exp. Agr. Anim. Husb. 8*, 33-9 (1968). *Soils Fert. 31*, 2882. The response of *Phalaris*-subterranean clover pasture to N, P, and S applications was measured on sedimentary soils (pH 5.33-5.36) at two sites. Response to 1-2 cwt/acre super was greater with a low than with a high stocking rate; a similar pattern was found in respect to N, but S tended to depress yields at both stocking rates, indicating that less super was needed to maintain pasture production at high stocking rates. Available P increased with grazing intensity.

182 The Influence of Gypsum Particle Size on Pasture Response on a Sulphur Deficient Soil. K. D. McLachlan and D. G. de Marco (CSIRO, Canberra). *Aust. J. Exp. Agr. Anim. Husb. 8*, 203-9 (1968). *Soils Fert. 31*, 3531. On S-deficient basaltic soil, pasture response to gypsum applications in four particle sizes (<1 to >5 mm) was inversely proportional to particle size at 9.5 lb/acre S. At 38.1 lb/acre S, no significant effect of particle size on yield was observed. Rate of solution of S from the fertilizer affected yield more than did placement of the fertilizer. The main effect of the applied S was on the clover component of the pasture. Results suggest that a S content of 0.07% in mature plant tops indicates an adequate S supply.

183 Calcined Rock Phosphate as Fertilizer for Pasture and Cereal Production in Western Australia. M. G. Mason and W. J. Cox (Dep. Agr., South Perth, Aust.). *Aust. J. Exp. Agr. Anim. Husb. 9* (36), 99-104 (1969). *CA 71*, 48776. Experiments were conducted to evaluate the usefulness of calcined rock phosphate as fertilizer for pasture and cereal production in Western Australia. Rock phosphate and superphosphate were compared at equivalent levels of applied P for wheat and pasture production. Superphosphate was a significantly better source of P than calcined rock phosphate. Total pasture dry matter and wheat grain yields were also higher with superphosphate than with calcined rock phosphate. Visual P deficiency symptoms were apparent for the first 8 weeks after germination in plants treated with calcined rock phosphate. Where a high initial P response is expected calcined rock phosphate is an inefficient source of P as compared with superphosphate.

184 Effect of Fertilizer Nitrogen on Digestibility and Voluntary Intake of *Chloris gayana, Digitaria decumbens*, and *Pennisetum clandestinum*. D. J. Minson (Cunningham Lab., St. Lucia, Aust.). *Aust. J. Exp. Agr. Anim. Husb. 13* (61), 153-7 (1973). *FA 6*, 1382. On five occasions during the growing season *Chloris gayana, Digitaria decumbens*, and *Pennisetum clandestinum* were fertilized with urea at 125 or 500 kg/ha and cut after 1 month's regrowth. The minimum N level in herbage was 0.96% and hence voluntary intake of these feeds was not limited by a N deficiency *per se*. Fertilizing at the high level increased dry matter yield ($P < 0.01$) and depressed the leaf percentage significantly in *C. gayana*. Each cut was fed to ten wethers to determine digestibility and voluntary intake. The higher rate of N fertilizer increased the overall mean dry matter digestibility 2.2%, organic matter digestibility 1.3%, and voluntary intake of dry matter 2.3 g/kg $wt^{0.75}$ ($P > 0.05$). Within the harvests significant increases and decreases in

digestibility and voluntary intake were found. The direction and magnitude of these changes in feeding value were not correlated with differences in yield, leaf percentage, or N content.

185 The Nutritive Value of Tropical Pastures. D. J. Minson. *J. Aust. Inst. Agr. Sci. 37* (3), 255-63 (1971). *Trop. Abstr. 27*, 872. In this review the results obtained from laboratory, animal house, and grazing studies with different tropical pasture species and varieties are considered together with the management factors that influence their nutritive value. The digestibility of pasture has been estimated by many techniques including proportion of leaf, chemical composition, and fermentation with rumen bacteria. Very good results were obtained with the technique based on the rate of digestion of samples of *Chloris gayana* in vitro, but results were less satisfactory when this technique was applied to different varieties of *Panicum*. Detailed attention is paid to N deficiency, which may be overcome by: (a) applying fertilizer N to the pasture; (b) introducing a legume; and (c) feeding supplementary N.

186 The Effects of Grazing on the Phosphorus Requirement of an Annual Pasture. P. G. Ozanne and K.M.W. Howes (Western Aust. Lab., Wembly). *Aust. J. Agr. Res. 22* (1), 81-92 (1971). *FA 4*, 1052. The applied P requirement of a pasture sown to subterranean clover was measured with and without grazing. Under moderate grazing pressure, in the yr of establishment, the pasture required about 50% more P than when ungrazed. In the following season, at a higher stocking rate, the grazed area needed twice as much P as the ungrazed to make 90% of their maximum growth. In both yr this difference in requirement between stocked and unstocked treatments was present throughout the growing season. Increased P requirement under grazing is associated with the need for greater uptake of P under conditions where redistribution of absorbed P within the plant is prevented by defoliation. It does not appear to be due to effects of defoliation on root size. Neither does it depend on differential light interception nor on changes in botanical composition.

187 Some Influences of Straw Mulch, Nitrogen Fertilizer, and Oat Companion Crops on Establishment of Sabi Panic. K. G. Rickert. *Trop. Grassl. 4* (1), 71-5 (1970). *Trop. Abstr. 26*, 369. Sabi panic (*Panicum maximum*) was sown with a companion crop of oats at three stages of development and with various rates of straw mulch and N fertilizer in subcoastal southeastern Queensland. Straw mulch reduced soil drying rate and soil temperature at 1 cm and improved seedling emergence. Maximum emergence occurred with a mulch of 8 to 10 tons/ha. Companion crops adversely affected establishment. Applications of N up to 160 kg/ha did not affect emergence, but improved dry matter production of sown grass.

188 Influence of Early Pasture Growth on Water Movement and Leaching of Potassium and Other Cations from Sandy Soils in a Mediterranean Environment. F. J. Roberts (CSIRO, Div. Plant Ind., Floreat Park, West. Aust.). *Aust. J. Exp. Agr. Anim. Husb. 10* (43), 203-8 (1970). *FA 4*, 505. Water and cation losses from two soil types were studied in monolith lysimeters fertilized with 375 kg KCl (50% K)/ha and 375 kg superphosphate (22% Ca)/ha, in which subterranean clover was grown. An advance of 5 weeks in time of sowing and germination reduced the mean percolate loss from 26 to 16 cm; the unsown control lost 31 cm. Potassium leaching decreased from 77 to 37 kg/ha and the unsown treatment lost 87 kg/ha. Magnesium decreased from 26 to 10 kg/ha and the unsown treatment lost 31 kg/ha. With Ca there was a marked decrease from 132 to 51 kg/ha; the unsown control lost 164 kg/ha. Cation leaching was most severe during the first part of the growing season. Early plant growth reduced cation leaching by increasing the water use and cation uptake. The early sown treatment contained 136 kg K/ha in 9500 kg/ha dry matter total tops, whereas the late sown treatment had 94 kg K/ha in 6300 kg/ha dry matter total tops. The decreased uptake was similar in magnitude to the increase in leaching loss of K.

189 Effect of Phosphorus and Sulfur Fertilization on the Growth and Distribution of Dry Matter, Nitrogen, Phosphorus, and Sulfur in Townsville Stylo (*Stylosanthes humilis*). P. J. Robinson and R. K. Jones (Div. Trop. Pastures, CSIRO, Townsville, Aust.). *Aust. J. Agr. Res. 23* (4), 633-40 (1972). *CA 77*, 87006. Large yield responses to P and S and a highly significant interaction were observed when Townsville stylo was grown in pots in a siliceous sand from north Queensland. Deficiency of P or S caused a 3-week delay in flowering. Seven successive harvests between 33 and 123 days showed a rapid decline in the concentrations of N, P, and S in all plant parts, except the flowers, of adequately fertilized plants. These plants contained only 0.02% P and 0.1% S in the mature leaf, but 0.36% P and 0.36% S in the seeds.

190 Implications of the Effect of Nitrogen on Daily Pasture Growth Rates in the Semiarid Subtropics. J. S. Russell. *J. Aust. Inst. Agr. Sci. 34* (3), 169-70 (1968). *Trop. Abstr. 24*, 602. In southern Queensland, an experiment was carried out on *Chloris gayana* established on a low fertility solodic soil. The mean annual rainfall at this location is 650 mm, most of it falling between Oct. and Mar. On Nov. 21, 1967, 4 rates of N as urea, 2 rates of K as KCl, 2 rates of lime, 2 rates of trace element frit FTE-503, and a basal superphosphate dressing were applied. From Jan. 8 to Feb. 5 daily growth rates were 9, 66, 99, and 115 kg/ha dry matter with 0, 45, 90, and 180 kg/ha N, respectively. During this period of relatively adequate moisture applied N resulted in a more than tenfold increase. Theoretical and practical implications in relation to rate of evapotranspiration, uptake mechanisms, and field aspects are discussed.

191 Plant Growth on a Low Calcium Status Solodic Soil in a Subtropical Environment. I. Legume Species, Calcium Carbonate, Zinc, and Other Minor Element Interactions. J. S. Russell. *Aust. J. Agr. Res. 17* (5), 673-86 (1966). *Trop. Abstr. 22*, 317. Large areas of solodic soils of very low Ca status occur in southern Queensland. *Trifolium repens* grown on this type of soil showed a poor yield even with an adequate P supply; it could be ameliorated by liming, while lime + Zn substantially increased the yield. Smaller increases were obtained with *Phaseolus lathyroides*; lime without Zn depressed the yield; sulfur decreased soil pH but a positive lime x S interaction was obtained. Copper deficiency uncomplicated by lime interaction was found in *T. repens*. There was no evidence of Mo deficiency or of a Mo x lime interaction. Beneficial effects of lime were associated with both Zn deficiency and mineral element toxicity.

192 Effects of Legumes and Fertilizer Nitrogen on Productivity of Green Panic Swards at Gayndah, Southeastern Queensland. W. J. Scateni. *Queensl. J. Agr. Anim. Sci. 25* (3), 85-91 (1968). *Trop. Abstr. 24*, 114. In S. E. Queensland dry-matter and N yields of the legumes *Glycine javanica*,

Phaseolus atropurpureus, Medicago sativa grown in association with *Panicum maximum* (variety *trichoglume*) were compared, under nongrazing, with yields of *Panicum maximum* swards fertilized with N. The legumes had little effect on the yield of *Panicum maximum*, and on the yield of other species, or yield of N. There was a marked yield response to N-fertilizer in the pure grass swards. In this environment, legumes should be regarded primarily as protein-rich herbage rather than as contributors of N to the companion grass.

193 A Way to Establish Townsville Lucerne. R. T. Strachan, F. C. Lambert, and M. Finlay. *Queensl. Agr. J. 93* (2), 110-12 (1967). *Trop. Abstr. 22*, 1394. A cheap method of establishing *Stylosanthes* with minimum cultivation was successfully tried on a 140-ha tract in a region of Queensland with an annual rainfall of 750 mm. The vegetation, open forest with a grass cover, was burned in Nov. and cultivated with scalloped-disk harrows immediately afterwards. *Stylosanthes* seed was sown in Dec. at a rate of 4.5 kg/ha mixed with sand on one half of the area and with 125 kg superphosphate on the other half. From Dec. to Mar. the area was stocked with 1 head of cattle/1.2 ha, or 3-4 times the normal rate, in order to minimize competition from grasses; the cattle did not graze the young *Stylosanthes* plants. Productivity of the legume was satisfactory even in the 1st yr, and a dense stand was obtained in the 2nd yr. The application of P fertilizer increased *Stylosanthes* yields by 36% except on a small part of the area which was not grazed.

194 Pastures for the Wet Tropical Coast—I. J. K. Teitzel. *Queensl. Agr. J. 95* (5), 304-11 (1969). *Trop. Abstr. 24*, 2774. This is the first of a series of articles on establishing and managing pastures for beef production at the wet tropical coast of Queensland. Attention is paid to: cattle fattening, need for fertilizer, climate, vegetation, soils, and improved pastures. It is possible to fatten cattle on high-quality pasture for most of the yr. Several fattening systems are in general use. It is possible to turn off either one or two drafts a yr. Establishment of grass-legume pasture on highly fertile rain-forest soils is not difficult and animal performance is good. For establishment of pastures in open forest and teatree (*Melaleuca* species) areas, P fertilizers are needed.

195 Responses to Phosphorus, Copper, and Potassium on a Granite Loam of the Wet Tropical Coast of Queensland. J. K. Teitzel. *Trop. Grassl. 3* (1), 43-8 (1969). *Trop. Abstr. 25*, 631. In Queensland, attempts to establish improved pasture on a dark grey sandy loam derived from granite have not been successful. Results from 2 experiments on this soil type confirmed the severe P deficiency and showed that Cu and K were also limiting plant growth. The effect appears to be an additive one. The legumes (*Stylosanthes guyanensis* and *Phaseolus atropurpureus*) responded to Cu in the presence of additional P and K only in the presence of both Cu and P. Guineagrass (*Panicum maximum*) responded to additional K when the P status was adequate but not to Cu.

196 Fertility of Pasture Soils in the Wet Tropical Coast of Queensland. III. Basaltic Soils. J. K. Teitzel and R. C. Bruce (Res. Sta., Dep. Primary Ind., South Johnstone, Aust.). *Aust. J. Exp. Agr. Anim. Husb. 12* (54), 49-54 (1972). *CA 77*, 47272. Fertilizer rate experiments were conducted on various basaltic soils under glasshouse and field conditions. The effect of added P, S, K, Ca, Mg, B, Mo, Cu, Zn, and Mn on the yield of various indicator plants growing in basaltic soils was evaluated. Responses to added P were found in 13 of the 15 soils studied, but large dry matter gains were only found in pot experiments with the surface 6 in. of the soils. Calcium carbonate applied at a rate of 560 kg/ha generally increased plant growth and Mo increased its growth in most cases significantly, especially on soils from freshly cleared rainforest. The role played by various elements in the fertility of basaltic soils in wet tropical regions is discussed.

197 Fertility Studies of Pasture Soils in the Wet Tropical Coast of Queensland. IV. Soils Derived from Metamorphic Rocks. J. K. Teitzel and R. C. Bruce (Res. Sta., Dep. Primary Ind., South Johnstone, Aust.). *Aust. J. Exp. Agr. Anim. Husb. 12* (56), 281-7 (1972). *CA 77*, 87071. Soils derived from metamorphic rocks and vegetation associations common to them were referred to as metamorphic soils. The soils were screened for possible deficiencies of S, Ca, Mg, B, Mo, Cu, Zn, and Mn. Molybdenum, Ca, K, and Mg treatment significantly increased plant growth in some experiments. Phosphorus brought about large plant growth increases in all trials. There were significant negative responses to Cu treatments in some experiments and to Mg in one. The Ca, Cu, Zn bulk treatment markedly improved seedling survival and increased dry matter yields 4.5-fold. In one trial, the Mg, S, B, and Mn bulk treatment increased yields; sulfur was considered to be the functional element in the bulk treatment. Molybdenum responses in 6 of the 9 general nutrient experiments ranged from 15 to 98% increase in plant growth. Molybdenum also increased the plant N content by ~33%. Its chief function, therefore, seemed to be in the efficiency of the *Rhizobium*-legume system of N fixation. Calcium treatments acted as a carrier of Mo, but Ca sometimes increased yields in the presence of Mo. The main function of Ca seemed to be that of overcoming Al toxicity. Sulfur brought about significant plant growth increases in four trials, evidently because these soils lacked S to some degree. Magnesium had no additive effect. Copper sometimes reduced yields, evidently because of a Cu-Mo antagonism.

198 Fertilizer for Granitic Soils in Wet Tropics. J. K. Teitzel and R. C. Bruce. *Queensl. Agr. J. 96* (7), 465-70 (1970). *Trop. Abstr. 26*, 362. A 6-yr research program was conducted in northern Queensland to determine the fertilizer requirements of grass and legume pastures on coarse, sandy granitic soils. These soils are deficient mainly in P and furthermore in K, Cu, Zn, S, and Ca. The role of these nutrients under various conditions is discussed, and fertilizer recommendations for poorly, as well as for well-drained, soils with various natural vegetation types are presented.

199 Pasture Fertilizers for the Wet Tropics. J. K. Teitzel and R. C. Bruce. *Queensl. Agr. J. 98* (1), 13-22 (1972). *Trop. Abstr. 27*, 2682. Results are reviewed of research conducted in Australia aiming at the assessment of fertilizer recommendations for different pasture lands of the wet tropical coast. Fertilizer recommendations are presented and discussed for the development of pastures on basaltic soils, granitic soils, beach sand soils, and alluvial soils for different vegetation types. Future lines of research are indicated.

200 Relative Efficiency of Two Sources of Phosphorus in the Establishment of Tropical Pasture Species. J. K. Teitzel and R. C. Bruce (Trop. Agr. Res. Sta., Queensland Dep. Primary Ind., South Johnstone, Aust.). *Queensl. J. Agr. Anim. Sci. 26* (2), 235-41 (1969). *CA 72*, 54292. Low-grade phosphate rock from Christmas Island, consisting of apatite, crandallite, and millisite, was calcined at 450° and compared

with superphosphate as a source of P for tropical pasture plants in pot and field experiments. Although a useful alternative source of P, the calcined phosphate was only 66-71% and 42-5.% as efficient as superphosphate in terms of the dry matter yield of guineagrass (*Panicum maximum*) and centro (*Centrosema pubescens*), respectively.

201 Nitrogen Fertilizer Responses of a *Heteropogon contortus* and a *Paspalum plicatulum* Pasture in Relation to Rainfall in Central Coastal Queensland. L.'t Mannetje and N. H. Shaw (Div. Trop. Past., CSIRO, Cunningham Lab., St. Lucia, Australia). *Aust. J. Exp. Agr. Anim. Husb. 12* (54), 28-35 (1972). *Soils Fert. 35*, 3519. The effects on an indigenous pasture of predominately *H. contortus* and a sown pasture of *P. plicatulum* of up to 336 kg N/ha annually as three split applications of urea were studied. The response was linear and averaged ~22 kg/ha/yr/kg N for both pastures. Nitrogen recovery was up to 50% and 336 kg N/ha doubled plant N to 2%. Yield responses and N recovery were linearly related to summer rainfall. The high N levels eliminated *H. contortus* and at low N levels *H. contortus* partly replaced *P. plicatulum*.

202 Isotopic Studies on the Uptake of Nitrogen by Pasture Plants. III. The Uptake of Small Additions of ^{15}N-labeled Fertilizer by Rhodesgrass and Townsville Lucerne. I. Vallis, *et al. Aust. J. Agr. Res. 18* (6), 865-77 (19[illegible]). *Trop. Abstr. 23*, 782. In pot trials conducted in Australia with *Chloris gayana* and *Stylosanthes humilis*, grown separately or mixed under small applications of labeled N fertilizers, *C. gayana* strongly competed with the legume for available soil N. Consequently, N uptake by the legume in mixed stand was only about 50% of that in pure stand. In mixed stand, N uptake of the grass during the first 9 weeks after sowing was about 20 times that of *S. humilis*, and about 8 times that between 9 and 13 weeks. Again in mixed stand, 47% of the N taken up by the legumes in the first 5 weeks was derived from the soil as against only 3% over 13 weeks. No significant transfer of unlabeled N from the legume to the grass occurred.

203 Nutrient Requirements of White Clover Based Pastures on a Krasnozem Basalt at Maleny, Southeastern Queensland. R. E. White. *Aust. J. Exp. Agr. Anim. Husb. 7* (29), 509-14 (1967). *Trop. Abstr. 23*, 792. Nutrient deficiencies of old *Pennisetum clandestinum* and *Paspalum dilatatum* pastures in Queensland were investigated. On the establishment of *Trifolium repens* significant responses to P, K, Mo, and lime were recorded; where the clover did not establish well, as in the *P. clandestinum* sward, the overriding deficiency appeared to be N. Maximum response to P was achieved at a rate equivalent to 1250 kg superphosphate/ha. An initial Mo application of 70 g/ha was adequate; the main effect of lime was to release Mo in the acid soil (pH = 4.6). Aluminum and Mn were not toxic; nevertheless, lime increased the yield and N content of clover grown in pots, possibly due to preferential nodule formation by the introduced rather than the native rhizobia at the higher soil pH.

204 The Comparative Response of Tropical and Temperate Grasses to Varying Levels of Nitrogen and Phosphorus Nutrition. J. R. Wilson and K. P. Haydock (Div. Trop. Pastures, CSIRO, Cunningham Lab., St. Lucia, Australia). *Aust. J. Agr. Res. 22* (4), 573-87 (1971).*Trop. Abstr. 27*, 632. In Australia, the response of ten temperate and nine tropical grasses to N and P at rates varying from 0 to 269 and from 0 to 1004 kg/ha, respectively, was studied. There was a gradation in species response in all attributes studied without an absolute dividing line between the 2 groups of grasses. On average, however, the tropical grasses behaved differently from the temperate ones in some important aspects of their growth and response to N and P. Moreover, the results established that the tropical grasses have the potential to produce high-quality fodder. The reasons why this potential is rarely achieved under field conditions are subjected to further study.

205 Seed and Nutritional Aspects of Grass-Townsville Stylo Competition. L. E. Woods and R. A. Dance. *J. Aust. Inst. Agr. Sci. 36* (1), 45-7 (1970). *Trop. Abstr. 26*, 667. The proportion of annual grasses in Townsville stylo pastures in Australia was related to the amount of grass seed present. The proportion was increased by the application of superphosphate on a soil low in available P, but was unaffected by applied N.

206 Townsville Stylo for Hay in the Peninsula. J. W. Wright. *Queensl. Agr. J. 97* (9), 473-8 (1971). *Trop. Abstr. 27*, 2687. Production of Townsville stylo (*Stylosanthes humilis*) in Queensland is comprehensively reviewed. Attention is paid to soil types, land preparation, crop establishment, fertilizer, and maintenance requirements. Details are presented on methods of sowing; regular distribution of pure seed is difficult and mixing with superphosphate in a ratio of 1:6 for seed and fertilizer, respectively, prior to sowing by aircraft, combine or seedbox, or fertilizer spinner is practiced. For handsowing mixing with sawdust is advised. Many details are provided on rolling of seeded area, management stage of cutting, and haymaking. Hay yields amount to 5.5 tons/ha on good areas as against an average of 2.2-3.5 tons/ha.

BURMA

207 The Role of the Agricultural Adviser in Burmese Agriculture. Comments on Achievement During an F.A.O. Assignment. L. C. Snook. *J. Aust. Inst. Agr. Sci. 33* (3), 192-7 (1967). *Trop. Asbtr. 23*, 531. Application of superphosphate at a rate of 168 kg/ha was found to be very advantageous for the establishment of leguminous pasture crops on eroded wastelands in the dry regions of central Burma. *Stylosanthes humilis* imported from Queensland (Australia) in experiments proved to be a very useful pasture legume in the drier parts as well as in the high rainfall areas of central Burma and on the grassy plains of the Shan State. Rearing of the Burmese type of sheep on such improved pastures for carpet wool production may turn out very profitable. Cattle farming on perennial pastures in the high rainfall areas of Lower Burma for milk and beef production appears promising as well.

INDIA

208 Study on the Pasture Establishment Technique. V. Effect of Reseeding of Natural Pastures with *Cenchrus ciliaris* by Different Soil Working Methods and Fertilizer Treatments on Pasture Production. A. K. Chakravarty and C. M. Verma. *Ann. Arid Zone 9* (4), 236-44 (1970). *Trop. Abstr. 27*, 126. In India, field experiments conducted for 3 yr showed that sowing the grass *C. ciliaris* after plowing the soil (as compared with other soil working treatments) resulted in the highest seed germination rate. The treatment also increased the fodder yields by 50, 18, and 37% in the 1st, 2nd, and 3rd yr, respectively. Application of N alone or in combination with P or P and K increased the height and tillering of the plants. Fodder yield increase was only obtained in the first yr.

Economics of the treatments are discussed.

209 Herbage Production with Fertilizer Nitrogen and Legumes. R. D. Singh, *et al. J. Indian Soc. Soil Sci. 16* (4), 331-6 (1968). *Trop. Abstr. 24*, 2780. In Bihar, the grass *Pennisetum polystachum* was grown alone and fertilized with 30, 55, or 80 kg N/ha, and grown in combination with two summer perennial legumes without N-application, to assess the N equivalence of the legumes for the production of forage crops. The grass gave a linear response to N addition, about 45 kg dry matter was obtained for each kg of applied N. On dry matter basis, the amount of N required by grass alone to produce the same effect as that of the legumes was interpolated to be 32 and 74 kg N/ha for *Stylosanthes gracilis* and *Centrosema pubescens*, respectively; the corresponding figure interpolated on protein yield basis were 41 and 97 kg N/ha.

210 Growth Analysis of Perennial Grasses in Tropical India. I. Herbage Growth in Pure Grass Swards. R. D. Singh and B. N. Chatterjee. *Exp. Agr. 4* (2), 117-25 (1968). *Trop. Abstr. 23*, 1640. In Bihar, 12 perennial pasture grasses were compared at two cutting frequencies during 3 yr after sowing or planting at an altitude of 625 m. The region receives 1321 mm rain/yr, almost all in June-Oct., and is subject to ground frosts in winter; the field received 44 kg N + 34 kg P_2O_5/ha/yr. The highest mean annual dry-matter yield/ha (10 tons with frequent and 14.7 tons with less frequent cutting) was obtained from *Andropogon gayanus* which also gave the highest proportion (10-12%) of its total yield during the dry winter season. *Brachiaria brizantha* showed a slower initial development but in the next yr yielded about as much as *A. gayanus*. Differences in yields between species appeared to be mainly due to differences in leaf area index.

ISRAEL

211 Fertilizer Application to Arid Pasture. III. First Year Aftereffects (1967/68). R. Benjamin and N. H. Tadmor (Div. Pasture Res., Volcani Inst. Agr. Res., Bet Dagan, Israel). *Makhon Volcani Le-Heker Ha-Hakla'ut, Sekirah Makdimah*, No. 660, 12 pp. (1969) (Hebrew). *CA 73*, 130256. Fertilizer aftereffects were studied on a light loess soil containing sand 30-40, dust 40-50, and loam 15-20%. Phosphorus fertilization gave a 100% increase in yield when no N had been applied, whereas the increase was 20-30% with high N levels. Nitrogen fertilization increased the yields by nearly 200% in the absence of P and by nearly 100% in the presence of P.

212 Responses of Rhodesgrass and Overseeded Legumes to Nitrogen and Potash Fertilizers and to the Availability of Soil Potassium in Israel. A. Dovrat. *Exp. Agr. 2* (4), 255-63 (1966). *Trop. Abstr. 22*, 117. An irrigated field of *Chloris gayana* in Israel, receiving 70 kg P/ha annually, was cut eight times/yr from spring to autumn; annual legumes sown into the grass in autumn were cut several times in winter and spring. Grass dry-matter yields in 3 yr increased linearly with N fertilizer rates from 4 tons/ha in plots without N to 12 tons/ha in plots receiving 430 kg N/ha in eight split applications, one after each cutting. Potassium uptake without extra K fertilizer increased concomitantly from 26 to 55 kg/ha; potassium fertilizer increased the K content of the grass but not its yield. Legume yields decreased with increasing K uptake by the preceding grass crop but could be restored to normal levels by an application of 60 kg K/ha in autumn. Availability of soil K decreased with increasing N fertilizer rates

213 The Influence of Defoliation and Nitrogen on the Regrowth of Rhodesgrass (*Chloris gayana* Kunth). II. Etiolated Growth and Nonstructural Carbohydrate, Total-N, and Nitrate-N Content. A. Dovrat, B. Deinum, and J.G.P. Dirven (Hebrew Univ., Rehovot, Israel). *Neth. J. Agr. Sci. 20* (2), 97-103 (1972). *Soils Fert. 35*, 5473. Pot-grown grass plants fertilized with 8.29 meq N/100 g soil as ammonium nitrate contained 30% less carbohydrate in the stubble and roots than those fertilized with 1.43 meq N/100 g soil. The total N content of the shoots and stubble was almost double with high as compared with low N applications, and the nitrate content of the herbage was 47 and 12% of the total N respectively. The nitrate content was negatively correlated with the carbohydrate level, and the amount of etiolated growth was positively correlated.

214 Role of Potassium in the Regrowth of Subtropical Rhodesgrass (*Chloris gayana* Kunth). T. Kipnis and A. Dovrat (Agr. Res. Org., Volcani Center, Dep. Agron., Beit Dagan, Israel). *Potash Rev. 7-12*, 1-2 (1972). *Trop. Abstr. 28*, 902. Pot trials with rhodesgrass conducted in Israel showed that availability of K at time of regrowth is important for dry matter production. Combination of high K and high NO_3 raised plant yields by 84 and 145% at 14 and 28 day cutting intervals, respectively, as compared to responses to low K and low NO_3. Similar results were obtained in the case of high K and high NH_4; this treatment also increased the number of tillers/pot by 27%. Brief attention is given to the kinetics of some metabolizable substrates.

215 Yield Responses of Irrigated Alfalfa (*Medicago sativa* L.) to Available Soil P and K Levels in Different Fertilizer Treatments in the Hula Valley of Israel. I. Levin, A. Dovrat, and J. Mozes. *Israel J. Agr. Res. 19* (1), 25-30 (1969). *Trop. Abstr. 24*, 1801. In two trials with irrigated lucerne, conducted in Israel on an alluvial soil four rates of P and K fertilizers were applied to the 0-20 cm layer with or without basic dressings of 340 kg P or 240 kg K/ha. Phosphorus gave no yield responses; in the control plots soil P decreased from 17.0 to 11.0 ppm in the 0-20 cm layer, and from 15.0 to 10 ppm in the 30-40 cm layer. A total of nine cuts in the 3rd yr showed an increase from 8.9 to 13.4 tons dry matter/ha, when K increased from 0 to 1800 kg/ha in the upper layers, and from 10.8 to 13.4 tons/ha when K was increased in the deeper soil layers, followed by 660 kg K/ha in three split dressings. These favorable yield effects could be related to uniform distribution over 0-40 cm and to high K availability in the surface soil.

216 Fertilization of Annual Range in Northern Israel. Yitzchak Ofer and No'am G. Seligman (Soil Conserv. Drain. Sect., Min. Agr., Beersheba, Israel). *J. Range Manage. 22* (5), 337-41 (1969). *CA 72*, 11682. Field plot trials (one-fourth acre) were run for 2 yr to measure the effect of nitrogenous [$(NH_4)_2SO_4$] and phosphatic (superphosphate) fertilizers on meadows composed of mixed annual Mediterranean species. At one site the dominant species was *Stipa tortilis* and at the others the dominant grass was *Avena sterlis*. Significant responses were obtained where the vegetation grew on terra rossa, on colluvium alluvium derived from terra rossa, and on reddish-brown basaltic grumosol. On dark-brown basaltic grumosol and on light-colored rendzina the response was too small to be of importance. On terra rossa, P alone produced the most economic yield increase. The effect of fertilization was larger and more consistent on early growth than on the flush season yield.

SRI LANKA

217 Kikuyugrass–*Pennisetum clandestinum*, Hochst ex Chiov and Its Value in the Montane Region of Ceylon. I. Agronomic Aspects. W. D. Andrew and A.B.P. Jayawardana. *Trop. Agr., Ceylon 127* (1), 23-42 (1971). *Trop. Abstr. 27*, 133. The use of kikuyugrass (*Pennisetum clandestinum*) in Ceylonese pastures is comprehensively evaluated. Attention is paid to botanical aspects, growth habit, environment, chemical composition, methods of establishment, management aspects, and pests and disease control. Details are given on the application of N, P, K, S, Ca, Mg, and microelements especially Cu, Zn, B, and Mo. Annual dressings to regularly grazed land of dolomite at 560 kg/ha/yr, and 40 kg N, 13 kg P_2O_5 and 21 kg K_2O/ha every 2 months are recommended. Every 3rd yr a blanket dressing should be given of copper- and zinc sulfate each at a rate of 7.8 kg, 11-22 kg borax, and 140 g ammonium molybdate/ha. Associate species for kikuyugrass in pastures are listed.

BOOKS AND REVIEWS

218 Tropical Pastures. W. Davies and C. L. Skidmore, editors. *London:* Faber and Faber, Ltd., 215 pp. (1966). Tropical pastures in their ecological setting are considered, and plants, animals, soil, and climate are discussed as interacting parts of the environment as a whole. Many of the authors have worked in the tropical environment for prolonged periods: the chapter each has contributed deals with his own specialized field.

219 Aspects of Pasture Development in the Tropics. J. G. de Geus. *Stikstof 13*, 29-47 (1969) (Eng). *CA 72*, 120503. This is a review of the development, economics, and fertilizing of tropical pastures.

220 Grasses and Grassland. J. S. de Geus. In *Fertilizer Guide for the Tropics and Subtropics. Zurich, Switzerland:* Centre d'Etude de l'Azote, 723-52 (1973) (Eng).

221 Some Aspects of Pasture Development in the Tropics. J. G. de Geus. *Stikstof 13*, 29-47 (1969). *Trop. Abstr. 25*, 2683. Climatic conditions, religious, or social traditions, and the economics of more intensive utilization of tropical pastures are bottlenecks for the development of major livestock industries. Attention is paid to the effects of over-grazing, carrying capacity, and supplemental sources of feed. Pastures may be improved by establishing grass/legume mixtures and introduction of selected grasses in combination with judicious fertilizing. Details are presented. A high level of managerial skill is required to fully utilize fertilizers to increase yields from 5000 kg/ha for volunteer forage to 50,400 kg/ha for napiergrass under optimum management and irrigation. In general, only dairying and fattening will be economic, whereas for rearing or just stocking of cattle, fertilizing is a questionable proposition.

222 Tropical Pastures. E. M. Hutton (CSIRO, Div. Tropical Pastures, Cunningham Lab., Brisbane, Australia). In *Advances in Agronomy 22*, 1-73 (1970). *New York*: Academic Press, 462 pp. (1970). The studies on the interrelationships between legume. rhizobium, plant nutrients, and soil type have made it possible to successfully establish legumes in pastures in most tropical areas. The finding that the majority of tropical legumes and their associated rhizobia are adapted to acid soils is of special significance in tropical development. Determination of critical percentages of the major elements sufficient for maximum growth of the different legumes has given a sound basis for fertilization of tropical pastures. Characterization of the associate grasses in this respect has commenced but requires much more attention if a proper understanding of the mineral balance in tropical pastures is to be obtained.

223 The Place of Legumes in Tropical Pastures. R. J. Jones. *ASPAC Tech. Bull. 9*, 69 pp. (1972) (Eng). Tropical legumes are shown to hold a primary place in the development of pastures in the tropics. Their exploitation for use in pastures depends essentially on the choice of the correct legume for a particular environment and the establishment of an effective symbiosis with an efficient *Rhizobium* strain. The N contribution of this symbiosis is dependent upon the yield of legume grown. This is often limited in the tropics by inadequate nutrition which must be remedied if high inputs of N are to be achieved.

224 An Introduction to Tropical Grassland Husbandry. Robert J. McIlroy. *London:* Oxford University Press, 2nd edition, 160 pp. (1972). This volume is based on a series of lectures on grassland husbandry given to undergraduates of the University of Ibadan, Nigeria, as part of the bachelor of science (agriculture) degree, and is a good overall introduction to tropical pastures: economics, species, ecology, seed production, management and manuring, utilization, and conservation.

225 Grassland Farming. Part III. Establishment and Management of Tropical Pastures. C. Manidool. *ASPAC Ext. Bull. 21*, 29 pp. (1972) (Eng). A discussion for the farm operator on the adaptability of various tropical grass and legume pasture species, their soil preferences and soil fertility requirements, nutritive values and methods of management.

226 Proc. Int. Grassl. Congress, 10th., 1015 pp. (1966). (Held Univ. Helsinki, Finland, July 7-16, 1966). Finnish Grassland Association, Salomonkatu 17B 47, Helsinki 10, Finland.

227 Proc. Int. Grassl. Congress, 11th., 956 pp. (1970). (Held Surfers Paradise, Queensland, Australia, April 13-23, 1970). *St. Lucia, Queensland*: Univ. Queensland Press. This meeting in Queensland produced a large number of tropical and subtropical grassland oriented papers. Summaries of the papers are divided into sections covering all aspects of natural grasslands, sown pastures, plant improvement and fertilizers, animal nutrition, management of forage crops, and ecology.

228 Tropical Grasslands. v.p. CSIRO, St. Lucia, Brisbane, Queensland, Australia. The official journal and proceedings of the Tropical Grassland Society of Australia published three times per yr.

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ASPAC Extension Bulletin
ASPAC Technical Bulletin
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AUTHOR INDEX

Abruna, F. 82, 83, 85
Adams, W. E. 90
Akinola, J. O. 7
Allen, S. E. 91, 122
Altona, R. E. 18
Andrew, C. S. 132, 133, 134, 135, 136, 142, 176
Andrew, W. D. 217
Arroyo, D. 81

Barnes, D. L. 12, 13
Barth, K. M. 101
Bastidas, R. A. 51
Beaty, E. R. 93
Benjamin, R. 211
Beyers, C. P. 19, 20, 21
Biddiscombe, E. F. 175
Billy, Bahe 92
Blue, W. G. ..50, 67, 68, 69, 94, 115, 125
Blunt, C. G. 137
Blydenstein, J. 65
Boonman, J. G. 1, 2
Boultwood, J. N. 17
Bowen, J. E. 95
Box, T. W. 99
Braga, J. M. 36
Bruce, I. J. 140
Bruce, R. C. . 138, 139, 140, 196, 197, 198, 199, 200
Bryan, W. W. 141, 142

Caro-Costas, R. 82, 83, 84, 85
Carreker, J. R. 96
Cassidy, G. J. 143
Chacon, E. 126
Chakravarty, A. K. 208
Chatterjee, B. N. 210
Chesney, H.A.D. . 74, 75, 76, 77
Chicco, C. F. 126, 127
Clatworthy, J. N. 14
Colman, R. L. 144, 145
Cortes Padilla, H. 52
Cox, W. J. 183
Crack, B. J. 146
Crowder, L. 57

Dance, R. A. 205
Davidson, J. G. 89
Davies, W. 218
Davila S., V. 53
Dawson, R. N. 90
De Carvalho, M. M. ...35, 42
Decker, A. M. 97
De Franca, G. E. 35
De Freitas, L.M.M. ...38, 40
De Geus, J. G. .219, 220, 221
Deinum, B. 213
De la Torre, R. 70
De Marco, D. G. 182
De Matos, E. 70
Diamond, R. B. 98
Dirven, J.G.P. 213
Dobereiner, J. 44
Dovrat, A. ... 212, 213, 214, 215
Downes, R. W. 147
Drawe, D. L. 99
Duble, R. L. 108, 117

Echeverri E., S. 53
Edwards, N. C. 101
Ellis, W. C. 116
Emrich, E. S. 42
Escobar R., L. 54, 55
Evans, E. M. 100, 110
Evans, T. R. 148
Everett, M. L. 154

Fagbami, A. 8
Fassbender, H. W. 65, 66
Fayemi, A. A. 8
Febles, G. 71
Fernandes, A.P.M. 36
Figarella, J. 82
Finlay, M. 193
Fisher, M. J. 149
Fribourg, H. A. 101
Fuenmayor, C. E. 127

Gartner, J. A. 150, 151, 152, 153, 154
Gartrell, J. W. 155
Garza T., R. 81
Glencross, R. N. 155
Gomide, J. A. 36, 37
Graham, T. G. 156
Green, R. E. 124
Grisales G., A. 56, 63
Grof, B. 157, 158
Guerrero, R. 65, 66

Haggar, R. J. 9, 10
Hall, R. L. 159
Harding, W.A.T. 158
Harty, R. L. 160
Haydock, K. P. 204
Hegarty, M. P. 133
Hendy, K. 161
Henzell, E. F. 162, 163, 164, 165, 166
Herrera, P., G. 57, 60
Hill, G. D. 167
Hincks, A. E. 170
Hodges, E. M. 102
Holt, E. C. 116
Hoveland, C. S. 103
Howes, K.M.W. 186
Humphreys, L. R. 137
Hunt, C. M. 91
Hutton, E. M. 222
Huynh-Van-Nhan 6
Hyam, G.F.S. 18

Jayawardana, A.B.P. 217
Johnson, A. D. 134
Jones, M. B. 38, 39, 40
Jones, R. J. 223
Jones, R. K. ..172, 173, 189
Jones, R. L. 171
Jones, R. M. 174

Keay, J. 175
Kerridge, P. C. 176
King, L. D. 104
Kipnis, T. 214
Kleinschmidt, F. H. 177

Lambert, [illegible] C. 193
Langdale, G. W. 105
Laurin, R. 78
Lawrence, R. M. 93
Levin, I. 215
Lipsett, J. 178
Loftus Hills, K. 168, 169
Lotero C., J. 55, 57, 58, 59, 60, 64
Louw, A. J. 22
Lucas, L. N. 67, 68

McBee, G. G. 114
McCosker, T. H. 179
McCreery, R. A. 90
McGowan, A. A. 180
McIlroy, R. J. 224
McKell, C. M. 106
McLachlan, K. D. ..181, 182
McLaren, L. E. 79

Maignan, F. 78
Manidool, C. 225
Mason, M. G. 183
Matocha, J. E. 107, 108, 117
Mayer, B. G. 156
Mays, D. A. ...109, 110, 111
Michielin, A. 61
Miller, P. M. 23
Miller, S. F. 41
Minson, D. J. 184, 185
Moe, P. G. 31
Morris, H. D. 104
Morrison, J. 3
Motooka, P. S. 112, 113
Mott, G. O. 41
Mozes, G. 215
Mozzer, O. L. 42
Mundarain, R. 128
Murtha, G. G. 176
Myers, F. J. 98

Oakes, A. J. 129
Odu, C.T.I. 8
Ofer, Y. 216
Ogden, P. R. 92
Olsen, F. J. 30, 31
Oxenham, D. J. 166
Ozanne, P. G. 175, 186

Padilla, C. 71
Parra H., J. 62
Payne, H. 80
Pereira, J. F. 128
Pereira, R.M.A. 43
Perez Infante, F. 72
Perez S., A. 81
Pieters, W.H.J. 135
Powell, J. D. 93

Quagliato, J. L. 39, 40
Quinn, L. R. 41

Ramirez P., A. 55, 60
Reeves, S. A. 114
Rickert, K. G. 187
Roberts, F. J. 188
Robins, M. F. 136
Robinson, P. J. 189
Rodel, M.G.W. ...15, 16, 17
Rodriguez C., S. ...126, 127
Rodulfo, S. 115
Rouquette, F. M., Jr. ..108, 116, 117
Ruelke, O. C. 118
Russell, J. S. 190, 191

Sandland, R. L. 134
Scateni, W. J. 192
Schmidt, R. E. 119
Seligman, N. G. 216
Shaw, N. H. 201
Shoulders, J. F. 119

Singh, R. D. 209, 210
Skidmore, C. L. 218
Snook, L. C. 207
Souto, S. M. 44
Stephens, D. 32
Strachan, R. T. 193
Stroehlein, J. L. 92
Suttie, J. M. 4

Tadmor, N. H. 211
Tan, K. H. 120
Teitzel, J. K. . 194, 195, 196, 197, 198, 199, 200
Tergas, L. E. 69
Terman, G. L. . 91, 111, 121, 122
Tewari, G. P. 11
Thairu, D. M. 5
Theron, E. P. 24
Thomas, J. R. 105
't Mannetje, L. 201

Uribe H., A. 56, 63

Vallis, I. 202
Van Rensburg, H. J. 34
Van Zyl, L. G. 28
Verma, C. M. 208
Villamizar R., F. 64
Von Berg, D. A. 25
Vicente-Chandler, J. . .83, 84 85, 86, 87, 88
Vorster, L. F. 26

Walker, B. 29
Weir, C. C. 89
Wendt, W. B. 33
Werner, J. C. . 45, 46, 47, 48, 49
White, A. W. 90
White, R. E. 27, 203
Whitney, A. S. 123, 124
Williams, C. H. 178
Wilson, J. R. 204
Wollner, H. 73
Woods, L. E. 205
Wright, J. W. 206

Zantua, M. I. 125

Acroceras macrum, 12
Aluminum, effect on legumes, 134, 203
Ammonia, 214
Ammonium fertilizers, see specific sources: Ammonia, Ammonium molybdate, Ammonium nitrate, Ammonium sulfate, Calcium ammonium nitrate, Diammonium phosphate, Sulfur-coated urea, Urea
Ammonium molybdate, 217
Ammonium nitrate, 91, 100, 111, 213
compared with ammonium sulfate, 108, 154, sodium nitrate, 154, sulfur-coated urea, 109, urea, 97, 108, 109, 152, 154
Ammonium sulfate, 22, 29, 36, 53, 64, 76, 78, 79, 124, 126, 127, 216
compared with calcium ammonium nitrate, 163, ammonium nitrate, 108, 154, sodium nitrate, 154, 163, urea, 108, 152, 154, 163
Andropogon annulatus, 72
Andropogon caricosus, 72
Andropogon gayanus, 9, 10, 210
Andropogon pertusus, 72
Angletongrass, see *Dichanthium aristatum*
Avena sterlis, 216
Axonopus affinis, 141, 143, 150, 151
Axonopus compressus, see *Axonopus affinis*
Axonopus scoparius, 59
Bahiagrass, see *Paspalum notatum*
Beef production, 14, 17, 29, 37, 79, 81, 83, 84, 85, 99, 102, 117, 148, 156, 158, 165, 168, 181, 194, 207
Bermudagrass, see *Cynodon dactylon*
Biloela buffel, see *Cenchrus ciliaris*
Biuret, 18
Black speargrass, see *Heteropogon contortus*
Borate, see Boron fertilizer
Borax, 217
Boron fertilizer, 16, 34, 40, 197
Brachiaria brizantha, 210
Brachiaria mutica, 12, 72, 86, 169
Brachiaria purpurascens, 54
Brachiaria ruziziensis, 30, 86, 88
Bromus unioloides, 171
Brunswickgrass, see *Paspalum nicorae*
Buffelgrass, see *Cenchrus ciliaris*
Cajanus cajan, 71
Calcined phosphate, 178, 183
compared with superphosphate, 200
Calcium ammonium nitrate, 3, 14, 24, 30
compared with ammonium sulfate, 163, sodium nitrate, 163, urea, 163
Calcium carbonate, 196
Calcium fertilizer, see also specific sources: Calcium ammonium nitrate, Calcium carbonate, Calcium phosphate, Calcium silicate, Concentrated superphosphate, Gypsum, Lime, Superphosphate, 24, 35, 76, 188, 197
Calcium phosphate, 147
Calcium silicate, 68
Carpetgrass, see *Axonopus affinis*
Cenchrus ciliaris, 132, 157, 166, 169, 208
Centrosema pubescens, 8, 11, 33, 35, 142, 158, 168, 209
affected by calcium, 38, phosphorus, 38
Chicken manure, see also Organic fertilizers, 106
Chilean nitrate, 64
Chloris gayana, 6, 9, 15, 17, 30, 130, 131, 132, 163, 169, 171, 184, 190, 202, 212, 213, 214
digestibility, 185
seed production, 2, 24
Clitoria ternatea, 70
Coastal bermudagrass, see *Cynodon dactylon*
Cold resistance, 114, 118, 179
Concentrated superphosphate, 102
Congograss, see *Brachiaria ruziziensis*
Controlled release fertilizer, see also Sulfur-coated urea, 91, 122
Copper fertilizer, 20, 155, 195, 197
Cynodon dactylon, 37, 57, 79, 86, 97, 98, 104, 107, 109, 121
rate and time of nitrogen application, 55, 100, 101
response to phosphorus, 100, potassium, 90, 100
Cynodon niemfuensis, 83
Cynodon plectostachyus, 16, 17, 82
Cynodon spp., 7
Dactylis glomerata, 3
Dairy industry, 79, 145, 165, 207
Desmodium intortum, 27, 31, 113, 123, 137, 159
Desmodium spp., 168
Desmodium uncinatum, 142
Diammonium phosphate, 112
Dichanthium aristatum, 61, 78
Digitaria decumbens, 37, 56, 57, 73, 75, 77, 79, 80, 81, 83, 85, 125, 128, 131, 132, 165, 169, 179, 184
response to nitrogen, 48, 49, 52, 54, 63, 64, 72, 86, 89, 124, 126, 127, 148, 161, phosphorus, 50, 68, potassium, 118
Digitaria magroglossa, 144
Digitaria setivalva, 76
Dolichos biflorus, 147
Dung, see Organic fertilizer
Economics of fertilizer use, 41, 81, 86, 128, 165, 208, 216
beef production, 14, 17, 84
Elephantgrass, see *Pennisetum purpureum*
Eragrostis curvula, 18, 23, 26
Eragrostis lehmanniana, 92
Farmyard manure, see Organic fertilizer
FeEDTA, see Iron chelate
Fescue, see *Festuca arundinacea*
Festuca arundinacea, 109, 110, 121
Foliar application, 19, 21
sugar mill waste, 70
urea, 56, 71
Fritted trace elements, 75, 77, 190
FTE, see Fritted trace elements
Gambagrass, see *Andropogon gayanus*
General fertilizer recommendations, Australia, 141, 145, 146, 147, 155, 159, 168, 169, 193, 194, 197, 198, 199, 206, Brazil, 35, 40, 43, 49, Costa Rica, 69, Cuba, 73, Haiti, 78, Jamaica, 79, 80, South Africa, 23, 24, 25, Uganda, 31, 32, United States, 98, 103, 112, 113, 115, 119, 120
Giant Rhodesgrass, see *Chloris gayana*
Glycine javanica, 34, 35, 145, 168, 177, 192
affected by boron, 40, calcium, 38, phosphorus, 38, zinc, 40
Grass/legume pasture, 3, 4, 5, 9, 11, 13, 34, 123, 130, 137, 141, 143, 145, 158, 164, 168, 173, 175, 177, 181, 192, 194, 198, 202, 205, 209, 212
Green panicgrass, see *Panicum maximum*, var. *trichoglume*
Guineagrass, see *Panicum maximum*
Gypsum, 107, 182
Heteropogon contortus, 156, 201
Hyparrhenia rufa, 33, 36, 81
response to nitrogen, 51, 69, 72
Indigofera spicata, 142
Interactions: copper x molybdenum, 197, fertilizer x irrigation, 43, lime x sulfur, 191, manganese x nitrogen, 37, manganese x silicon, 95, nitrogen x phosphorus, 128, 151, nitrogen x potassium, 151, phosphorus x sulfur, 189, saline soil x NP fertilizers, 105, sulfur x magnesium, 107
Iron chelate, 125
Irrigation, 13, 51, 53, 57, 79, 96, 165, 177, 212, 215
effect on fertilizer, 43
sprinkler, 70, 100, 171
Jaraguagrass, see *Hyparrhenia rufa*
Kieserite, 74, 76
Kikuyugrass, see *Pennisetum clandestinum*
Kleingrass, see *Panicum coloratum*
Kudzu, see *Pueraria phaseoloides*
Leaching, 94, 122, 125, 139, 188
Legumes, see also Grass/legume pasture, 8, 27, 31, 34, 35, 38, 39, 40, 44, 70, 103, 133, 141, 146, 172, 177, 207, 209
deficiency symptoms, 135
effects of aluminum, 134, 203
response to phosphorus, 142, 147
Lehmann lovegrass, see *Eragrostis lehmanniana*
Leucaena leucocephala, 167
Lime, 6, 16, 19, 20, 23, 25, 31, 35, 40,

42, 47, 50, 67, 74, 75, 87, 100, 112, 125, 172, 190, 191, 203, 217
Liquid fertilizer, see also Foliar application, sewage sludge, 104
Lolium multiflorum, 121, 122
Lotononis bainesii, 142
Lovegrass, see *Eragrostis curvula*
Lucerne, see *Medicago sativa*
Macroptilium atropurpureum, 33
Magnesium fertilizer, see also Lime, Kieserite, 16, 32, 75, 77, 80, 107, 197
Manganese fertilizer, see also Manganese sulfate, 133, 197
increased by nitrogen, 37
Manganese sulfate, 44, 95
Manganese toxicity, 44
Manure, see Organic fertilizer
Matgrass, see *Axonopus affinis*
Medicago sativa, 13, 19, 20, 21, 31, 39, 40, 142, 174, 177, 192, 215
Melinis minutiflora, 36, 37, 132, 169
Micronutrient fertilizer, see specific sources: Boron, Copper, Molybdenum, Zinc
"Midland" bermudagrass, see *Cynodon dactylon*
Minor elements, see specific element: Boron, Calcium, Copper, Molybdenum, Sulfur, Zinc
Mixed pasture, see Grass/legume pasture
Molybdenum fertilizer, see also Sodium molybdate, 19, 20, 21, 155, 172, 174, 176, 196, 197, 203
Muriate of potash, see Potassium chloride
Nandi setaria, see *Setaria anceps*
Napiergrass, see *Pennisetum purpureum*
Natural pasture, 22, 29, 70, 72, 78, 156
Nilegrass, see *Acroceras macrum*
Nitrate, 214
Nitrogen fertilizer, see also Ammonium nitrate, Ammonium sulfate, Biuret, Calcium ammonium nitrate, Chilean nitrate, Sodium nitrate, Sulfur-coated urea, Urea, 5, 7, 8, 12, 26, 34, 41, 51, 52, 60, 86, 87, 119, 120, 123, 129, 145, 157, 161, 165, 167, 169, 177, 181, 185, 187, 209
application methods compared, 60
applied with organic fertilizer, 15
effect on Mn, 37, effect on seed production, 1, 2, 10
rate of application, 7, 17, 48, 54, 55, 58, 72, 88, 93, 101, 129, 131, 143, 144, 148, 150, 153, 169
recovery, 88, 89, 94, 108, 124, 150, 157, 161, 201
sources compared, 64, 97, 108, 109, 111, 122, 152, 154, 163
split application, 15, 49
time of application, 45, 54, 55, 110, 119, 144, 212
utilization, 94, 131
^{15}N, 202
Nitrogen fixation, 8, 33, 35, 130, 164, 197
Nitrogen loss, 162
NK fertilizer, see Potassium nitrate
NP fertilizer, 7, 22, 26, 28, 32, 50, 62, 92, 99, 105, 113, 204, 208, 210, 211
affected by soil salinity, 105
compared with chicken manure, 106
NPK fertilizer, 6, 11, 36, 42, 59, 61, 70, 74, 75, 76, 80, 82, 83, 84, 85, 86, 92, 103, 114, 116, 117, 121, 131, 151, 215
Nutrient deficiency, copper, 191, phosphorus, 189, potassium, 135, 152, sulfur, 174, 189, zinc, 191
Nutrient recovery, 117, 149
Organic fertilizer, 6, 15, 68, 104, 106, 187
Oxamide, 91
Pangolagrass, see *Digitaria decumbens*
Panicum coloratum, 116, 169
Panicum maximum, 9, 11, 30, 33, 36, 37, 41, 79, 113, 132, 168, 188, 195, response to N, 51, 54, 72, 86, 152, 153, 158, 169, 187, 192
Panicum maximum, var. trichoglume, 177, 192
Panicum repens, 12, 17
Paspalum commersonii, 169
Paspalum dilatatum, 24, 131, 132, 141, 143, 144, 150, 151, 203
Paspalum nicorae, 93
Paspalum notatum, 14, 36, 72, 100, 103, 120
Paspalum plicatulum, 14, 131, 201
Paspalum, spp. 171
Paspalum urvillei, 12
Pennisetum clandestinum, 24, 37, 53, 132, 141, 145, 150, 151, 154, 184, 203, 217
Pennisetum polystachum, 209
Pennisetum purpureum 28, 32, 37, 84, 129, 131, 168, 169
response to nitrogen, 51, 58, 60, 65, 66, phosphorus, 66
varieties compared, 42, 43
Pensacola bahiagrass, see *Paspalum notatum*
Phaseolus atropurpureus, 27, 34, 35, 192, 195
affected by calcium, 38, phosphorus, 38, 137, potassium, 136
Phaseolus lathyroides, 142, 191
Phaseolus purpureus, 168
Phosphate, see Phosphorus fertilizer
Phosphate rock, see also Calcined phosphate, 46, 47, 102, 139, 142, 178, compared with superphosphate, 172, 183, 200
Phosphorus fertilizer, see also Calcined phosphate, Calcium phosphate, Concentrated superphosphate, Diammonium phosphate, Potassium phosphate, Superphosphate, Triple superphosphate, 2, 24, 26, 27, 31, 33, 34, 35, 50, 67, 87, 132, 174, 175, 176, 181, 186, 189, 195, 196, 197, 203, 211, 215
comparison of phosphorus sources, 46, 102, 142, 178, 200
rate of application, 82, 137
PK fertilizer, see Potassium phosphate
Pigeon pea, see *Cajanus cajan*
Potash, see Potassium fertilizer
Potassium-calcium pyrophosphate, 90
Potassium chloride, see also Sulfur-coated potassium chloride, 14, 36, 76, 90, 136, 151, 188, 190
Potassium fertilizer, see also Potassium chloride, Potassium nitrate, Potassium sulfate, 26, 32, 33, 34, 35, 74, 87, 118, 159, 176, 195, 197, 203, 212, 214, 215
deficiency symptoms, 135
rate of application, 82
sources compared, 90
Potassium nitrate, 96
Potassium phosphate, 11, 53, 54, 57, 58, 60, 61, 63, 208
Potassium sulfate, 90
Pueraria phaseoloides, 35, 71
Residual fertilizer, 33, 99, 102, 142, 162, 173
Rhodesgrass, see *Chloris gayana*
Rice hulls, see also Organic fertilizer, 68
Rock phosphate, see Phosphate rock
Ryegrass, see *Lolium multiflorum*
Sabi panic, see *Panicum maximum*
St. Augustinegrass, see *Stenotaphrum secundatum*
SCU, see Sulfur-coated urea
Seed production, 1, 2, 10
Setaria anceps, 132, 159, 166
Setaria sphacelata, 30, 131, 137, 169, 171
seed production, affected by N, 1
Sewage sludge, see also Organic fertilizer, 104
Sheep production, 126, 127, 170, 184, 207
Silage, 9, 28
Silcon, see Calcium silicate, Sodium silicate
Siratro, see *Phaseolus atropurpureus*
Slow-release fertilizer, see Controlled release fertilizer, Sulfur-coated potassium, Sulfur-coated urea
Sodium molybdate, 19, 21
Sodium nitrate, compared with ammonium nitrate, 152, ammonium sulfate, 154, 163, calcium ammonium nitrate, 163, urea, 152, 154, 163
Sodium silicate, 68, 95
Soil nitrogen, 120, 138, 146, 172, 176
Soil pH, 47, 57, 67, 120, 124, 181

Soil phosphorus, 27, 44, 68, 115, 120, 138, 140, 176, 215
Soil potassium, 87, 159, 176, 212, 215
Soil sulfur, 172, 174
Soil tests, 197, 198, 199
Sprinkler irrigation, see Irrigation
Stargrass, see *Cynodon plectostachyus, Cynodon niem fuensis*
Stenotaphrum secundatum, 114
Stipa tortilis, 216
Stylo, see *Stylosanthes guyanensis*
Stylosanthes gracilis, 8, 9, 11, 31, 33, 113, 209
  affected by boron, 40, calcium, 38, phosphorus, 38
Stylosanthes guyanensis, 34, 137, 138, 142, 168, 195
Stylosanthes humilis, 27, 68, 146, 147, 149, 156, 160, 172, 173, 189, 193, 202, 206, 207
Subterranean clover, see *Trifolium subterraneum*
Sugar-mill waste, 70
Sulfur-coated potassium chloride, 122
Sulfur-coated urea, 91, 111
  compared with ammonium nitrate, 109, 122, urea, 98, 109, 122
Sulfur fertilizer, see also Ammonium sulfate, Gypsum, Kieserite, Manganese sulfate, Sulfur-coated urea, Sulfuric acid, Superphosphate, Zinc sulfate, 33, 35, 176, 181, 189, 197
  deficiency, 174
  sources compared, 107
Sulfuric acid, 39
Superphosphate, see also Concentrated superphosphate, Triple superphosphate, 4, 7, 14, 16, 22, 24, 29, 36, 47, 133, 138, 142, 151, 156, 165, 170, 173, 188, 193, 203, 206, 207, 216
  compared with phosphate rock, 183, 200
  effect on seed germination, 160, 205, soil N, 146
  rate of application, 7, 9, 12, 149, 160
  time of application, 180
Townsville lucerne, see *Stylosanthes humilis*
Townsville stylo, see *Stylosanthes humilis*
Trace elements, see specific element: Boron, Calcium, Copper, Molybdenum, Sulfur, Zinc
Trifolium repens, 143, 171, 176, 191, 203
Trifolium subterraneum, see also Legumes, 3, 170, 180, 186
Triple superphosphate, see also Concentrated superphosphate, Superphosphate, 66, 76, 112, 113, 128
2-amino-4-chloro-6-methyl pyrimidine, 89
Upright paspalumgrass, see *Paspalum urvillei*
Urea, 54, 57, 64, 66, 71, 89, 111, 126, 128, 151, 157, 171, 184, 190, 201
  application methods compared, 56
  compared with ammonium nitrate, 97, 108, 122, 152, ammonium sulfate, 108, 122, 152, 163, calcium ammonium nitrate, 163, sodium nitrate, 152, 163, sulfur-coated urea, 98, 109, 122
  split application, 65
Weeds, 167
White clover, see *Trifolium repens*
Winterkill, see Cold resistance
Zinc fertilizer, see also Zinc sulfate, 40, 42, 121, 155, 191, 197
  deficiency, 191
Zinc sulfate, 16

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