

Kikuyu Grass—*Pennisetum clandestinum*, Hochst ex Chiov and its value in the montane region of Ceylon

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1. Agronomic aspects

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INTRODUCTION

FOR many years it has been known that kikuyu is a valuable pasture grass, but it is only comparatively recently that its tremendous potential for animal production has been recognized in Ceylon.

The ecotype, now firmly established here, originally came from the Belgian Congo, *via* Australia. Seed from the Congo was planted in the Sydney Botanic Gardens, early in 1919 (11), and vegetative material from this source was sent to Ceylon about 1922 (9).

Under the relatively mild and good rainfall conditions that prevail in the montane zone of this island, which are very similar to those of its natural habitat, it has spread rapidly. As it has succeeded where many of the introduced European grasses have failed, it is now the most important pasture grass above 2,000'.

Being able to maintain a complete ground cover under heavy grazing, even when inadequately fertilized and indifferently managed it is the ideal grass for preventing soil erosion and arresting rapid run-off of rain water. Thus it is particularly valuable for protecting the steep water catchment areas of the montane zone. At the same time it can provide first class pasture for cattle and sheep. Therefore it qualifies for the title of grass "par excellence".

NOMENCLATURE

There are about 120-30 species of *Pennisetum* throughout the world most of which are found in the warmer regions. Many of them are valuable either as pasture or fodder grasses. A characteristic of

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the genus *Pennisetum* is that the flowers are surrounded by a ring of delicate bristles, hence this latin name. The specific name *clandestinum* was probably chosen for this grass because of its reproductive behaviour.

Kikuyu grass is indigenous to East Africa and its common name is derived from the fact that it occurs very extensively in the district of Kenya where the Kikuyu Tribe is to be found.

BOTANICAL DESCRIPTION

Kikuyu grass is a long-lived perennial couch-type of grass having stems that creep over the ground (stolons) and others that creep below the surface (rhizomes). Upright leaves and new stolons are produced from the nodes on both stolons and rhizomes and both root at the nodes when in contact with soil.

Various strains of kikuyu grass have been recognized according to their vegetative and/or reproductive behaviour. Three that have been described (5) are as follows:—

(i) MOLO—leaf, light-green, narrow ; plant has an appearance of fineness creeping stem, slender.

(ii) RONGAI—leaf, dark-green, broad and coarse ; creeping stem, heavy.

(iii) KABETE—leaf, intermediate (characteristics between those of MOLO & RONGAI) : creeping stem, also intermediate.

However, since the habit of plants change according to the way that they are managed, it is rather difficult to classify strains.

The Ceylon ecotype of kikuyu grass commonly has leaves about $\frac{3}{8}$ " wide and up to 18" long. They are covered with inconspicuous short-soft hairs but their sheaths are noticeably hairy. Ligules, found at the junction of leaf and sheath, are reduced to rings of hairs.

Flowers, encircled by a ring of bristles, are borne, on short stalks, in clusters of two to four, in the leaf axils, and are not visible without dissection. Each flower consists of two florets, the lower one usually being sterile. Florets commonly contain three stamens and a forked-feathery stigma, but sometimes the former are absent or do not produce viable pollen, in which case the floret is said to be male-sterile. Some very vigorous strains are genetically male-sterile, but a change in environment may change the behaviour of the plant. The Ceylon ecotype appears to be mostly hermaphroditic.

GROWTH HABIT

(i) *Vegetative*

Plants enlarge by means of both stolons and rhizomes. Whilst it is the fertility of the soil that generally determines the rate of growth rhizome development is always faster in a soil of loose, than in one of tight texture. Under favourable conditions plants quickly form a matrix of dense vegetation that effectively keeps the soil cool and moist and prevent the establishment of other species. The leaves, which ascend vertically from the stolons and rhizomes, can form a thick carpet of succulent herbage. If allowed to grow unchecked the leaves eventually flop over, but the stolons continue to produce layer upon layer of matted herbage. Whilst the proportion of leaf to stem primarily depends upon the age of the pasture, it can also change very much according to the way in which the pasture is grazed and fertilized.

(ii) *Reproductive*

When the appropriate climatic conditions prevail, the stigmas appear and protrude from the florets and, after being fertilized by pollen from another floret, wither away and disappear again. A seed may then develop in the ovary below. After the stigmas have disappeared the stamens then emerge, discharge their pollen on to the stigma of another floret, and then disappear. Thus cross pollination is assured. Younger (12) reports that at a continuous temperature of 10°C, stamens were not exerted, but at a continuous 27°C or with an alternating 21°C and 10°C they were. Stigmas and stamens commonly emerge at night and wither during the hottest part of the following day, but during misty wet weather may remain viable for longer than a day.

As seed can develop without the pollen tube entering the egg cell, the plant is described as a facultative apomictic.

In Ceylon, kikuyu flowers and seeds freely at most times of the year.

The seeds are dark brown, flat-ovoid, about $\frac{1}{8}$ " long and $\frac{1}{16}$ " broad. They are pointed at the end which was attached to the plant, and, at the other end, the short-withered style persists. New seeds normally are dormant for a few months.

After passing undigested through the intestine of a cow, as they commonly do, they quickly germinate in the dung.

Kikuyu also spreads vegetatively.

ENVIRONMENTAL REQUIREMENTS

This grass has evolved in an environment where the elevation ranges from six to ten thousand feet above sea level, the annual rainfall is 40 to 60 inches, the mean temperature is 55 to 64°F and the soils are mostly volcanic loams. Thus it is naturally adapted to growing on friable well-drained acidic soils under warm-temperate to sub-tropical condition where the light intensity is high and rainfall, during the warmer part of the year, good. The climate that prevails in the montane zone of Ceylon would thus appear to be ideal, and although the soils are genetically different from those where it evolved, they are quite suitable physically and their chemical composition can be appropriately adjusted by the use of artificial fertilizers.

(i) *Temperature*

Experiments have shown that a mean weekly-minimum temperature above 52°F is necessary for active growth of kikuyu (4). It can withstand light frosts and though these destroy the foliage they do not harm the rhizomes. However under such conditions this grass may not produce viable seed. Kikuyu is not very suited to tropical conditions at low elevation. It is thought that the lower limit of usefulness in Ceylon would be at about an elevation of 2,000 feet, but this has yet to be accurately determined.

(ii) *Rainfall*

It is generally believed that a minimum rainfall of 35" per an. is needed but this requirement would necessarily depend upon such things as rainfall distribution, topography, soil type etc. Because of its deep rhizomatous habit, kikuyu is quite drought resistant. Thus it is also suitable for the upland-dry zone which has only one main

KIKUYU GRASS—AND ITS VALUE IN THE MONTANE REGION OF CEYLON

rainfall season. Provided the soil is well drained, there would seem to be no upper limit to the amount of rainfall that kikuyu can withstand.

(iii) Soil

Although kikuyu, because of its rhizomatous habit, grows best on a loose-textured soil, it can also grow quite well on soils of medium to heavy texture. Thus both patana and jungle soils in the montane zone of Ceylon are, physically, quite suitable. As it needs good drainage it will not grow satisfactorily on swampy-deniya land. Kikuyu will tolerate high acidity in the soil.

As it is a heavy feeder, it is essential, if the soil is not rich in plant food, to provide this, artificially, by applying fertilizer or cattle manure. Failure to do this will result in disappointment or even complete failure.

Kikuyu can withstand heavy grazing and trampling, and in fact thrives under such treatment.

CHEMICAL COMPOSITION

The chemical composition of kikuyu grass is quite satisfactory but as the analysis of young leafy material is always better than older leaves and the more fibrous stolons, the composition of a complete sample of herbage will depend upon its stage of development.

Table (1).—Percentage composition of dry matter in *Pennisetum clandestinum* at various stages of growth, and for comparison, *Paspalum dilatatum* (3)

KIKUYU PASPALUM															
Young growth				12"-20" long				Old growth				18"-24" long			
				Leaf		Stem						Leaf		Stem	
Crude protein	..	24.50	..	13.80	..	11.60	..	5.20	..	13.30	..	8.80			
Crude fibre	..	20.00	..	30.50	..	33.90	..	31.70	..	36.20	..	43.20			
Total ash	..	10.20	..	7.60	..	7.60	..	7.10	..	6.90	..	6.40			
Soluble ash	..	8.90	..	6.20	..	6.10	..	3.60	..	5.20	..	5.30			
Lime (CaO)	..	0.40	..	0.60	..	0.48	..	0.72	..	0.60	..	0.32			
Phos. oxide (P ₂ O ₅)	..	1.00	..	0.45	..	0.44	..	0.21	..	0.39	..	0.37			

KIKUYU GRASS—AND ITS VALUE IN THE MONTANE REGION OF CEYLON

Note that the crude protein and ash contents of young kikuyu are high. However, in the more mature grass these values are lower and thus old kikuyu is inferior to young kikuyu in nutritive values. Tall kikuyu generally has a better analysis than tall paspalum.

The amount of silica-free ash and main chemical constituents of this fraction for these two grasses is shown in Table 2. It will be that kikuyu grass not only contains more total mineral matter but is richer in phosphorus and potassium than paspalum. Thus, so far as mineral constituents are concerned it is generally a much better pasture grass.

ESTABLISHMENT

As seed of kikuyu grass is not available commercially, it is usually established by planting pieces of rooted stem, having about two nodes, just below the surface of the ground, at intervals of about eighteen inches. Sloping ground should first be contoured and then the cuttings can be planted in the depressions.

Before planting, treat the whole area with dolomite. When this has been washed in apply a mixed fertilizer, or cattle manure, along the lines of planting, and after further rain plant the grass. Quantities of fertilizer to use are given in the section dealing with management.

MANAGEMENT

(i) *Fertilization*

All plants require essentially the same nutrients, but in different amounts and thus in different proportions.

No plant can use any one element properly unless all the other essential ones are available, and, increasing amounts of one element generally means that corresponding increases of the others must also be provided at the same time.

Table (2)—Ash Constituents of *Pennisetum clandestinum*, and (in brackets) *Paspalum dilatatum*
as percentage of drymatter (10)

	<i>Lowest</i>		<i>Highest</i>		<i>Average</i>		<i>No. of samples</i>
	..		..		..		
Silica free ash	..	7.00 (4.80)	..	11.40 (7.50)	..	9.00 (6.30)	.. 65 (19)
Calcium (Ca. 0)	..	0.28 (0.40)	..	0.52 (0.70)	..	0.39 (0.60)	.. 65 (19)
Phosphorus (P_2O_5)	..	0.61 (0.46)	..	1.15 (0.69)	..	0.86 (0.57)	.. 65 (19)
Potassium (K_2O)	..	3.20 (1.60)	..	5.70 (4.30)	..	4.60 (2.30)	.. 25 (19)

Provided that other growth requirements such as, genetic potential, water supply, temperature, sunlight regime etc., are not limiting, as the nutrient supply to the plant is progressively increased, there will be a corresponding increase in the amount of herbage produced. At first this response will be proportional to the amount of nutrient supplied, that is, it is a linear response, then with increasing amounts of nutrient the response becomes curvilinear, i.e., not proportional, and ultimately a stage is reached when no further increase in yield occurs despite an increase in nutrient supply. This then is the stage of maximum response. Further increases in nutrient supply will cause a depression in yield.

The initial application of fertilizer generally has the effect of increasing the mineral content of herbage and with increasing supply the mineral content remains fairly constant so long as the plant can utilize the mineral as fast as it is provided. When more is provided than can be utilized, the mineral concentration within the plant rises above normal and this phase is often described as luxury consumption. Thus the application of fertilizer changes both the amount of herbage produced and its composition and each will vary according to the environment under which the plant is growing.

If mineral matter accumulates in the plant tissue faster than it can be used, the herbage can become toxic to animals. Perhaps the best example of this is when nitrogenous fertilizers are applied and, for a short while afterwards, the nitrate content of the herbage becomes dangerously high. For this reason it is desirable to allow several weeks to elapse between the time of applying nitrogenous fertilizer to grass and feeding the herbage to animals. It should also be noted that nitrate toxicity can occur if there are insufficient of other essential elements for the plant to transform the nitrate to protein.

During misty weather, when there is insufficient rain to wash soluble fertilizer off the leaves, they may become scorched. Therefore the best time to apply fertilizer is when the minimum leaf surface is present, i.e., immediately after grazing.

As it is known that upland soils are naturally not well provided with nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, boron, zinc, copper and molybdenum, and as all of these are needed by plants, additional amounts need to be provided, for vigorously growing plants, in the form of either artificial fertilizer or animal manure.

Although unfertilized soil may provide a proper balance and sufficient amounts of zinc, boron, copper and molybdenum for kikuyu grass when heavy applications of other nutrients are made, particularly N, P & K, it may then become necessary to apply some, if not all of these minor elements. Sometimes animals suffer from a mineral-element deficiency before the grass shows signs of being short. It is possible for animals to be troubled with cobalt deficiency and yet none seems to be needed for the grass because it is not considered an essential element for plant growth. Landholders should therefore be constantly on the watch for evidence of nutrient deficiencies. The first indication will be loss of animal production and health. As the deficiency become more acute, the pasture will lose vigour and characteristic signs will become evident in either or both grass and animals. Unusual eating behaviour is often an indication of mineral imbalance.

Whilst it may be profitable to apply artificial fertilizer in amounts up to some point within the range of curvilinear response, the most profitable or optimum response is usually obtained somewhere within the range of the linear response phase.

In a favourable environment, such as in the upland wet-zone of Ceylon, an adequately fertilized and properly managed kikuyu grass pasture should be capable of producing 15,000 lb. of dry matter, per ac.p.an. Quantities of some of the minerals required in greatest amount for the production of this quantity of grass are shown in the following table :—

TABLE 3.—Approximate Quantities of various minerals in 15,000 lb. of young dried kikuyu grass (2)* and (10)

<i>Mineral</i>		(%)	(lb.)
Nitrogen (N)	..	3.79 ..	568
Phosphorus (P_2O_5)	..	0.86 ..	129
Potassium (K_2O)	..	4.60 ..	690
Magnesium (MgO)	..	0.71* ..	106*
Calcium (CaO)	..	0.39 ..	58
Total acid-soluble ash	..	9.00 ..	1,350

It will be evident from the values shown in table No. 3 that substantial amounts of mineral matter are needed by this grass, and as in all probability these cannot be provided, quickly enough, or at all, by the soil, heavy applications of fertilizers become necessary if the full potential of the kikuyu is to be attained.

(a) Nitrogen

It is well known that a vigorous grass, such as kikuyu, will readily respond to amounts of N as great as 600 lb. p.ac.p.an., but this is probably not the upper limit of response in the wet-montane zone, because of the liberal rainfall, mild temperature regime and high light intensity that prevail there. The response up to 400 lb. of N would be a linear one (6).

An experiment, at Ambawela, has shown that, of the various forms of nitrogenous fertilizer used, urea was the cheapest source of nitrogen, and that the application of one lb. of fertilizer nitrogen produced more than 20 lb. of kikuyu dry-matter. Prilled urea, low in biuret, should be used.

When the price of urea is Rs. 820.50 per ton, the cost of providing one lb. of nitrogen in this form, would be about 80 cents. However when calculating the cost of producing dry-matter by using nitrogenous fertilizer one must take into account the value of the other fertilizer that must be applied to allow the applied nitrogen to become fully effective. This would increase the cost of the dry matter by about 50 per cent. However as the cost of buying 20 lb. of dry-matter in the form of concentrate, of no higher feeding value than the dry-matter in kikuyu grass, is about Rs. 4.40, it becomes very evident that it is a much cheaper proposition to provide high quality dry-matter, in the form of grass, than as concentrate.

(b) Phosphorus

This can be most cheaply provided, in a readily soluble form, as concentrated superphosphate. However it should be noted that, unlike ordinary superphosphate, this type of phosphatic fertilizer does not contain any sulphur, which is an essential element.

(c) Potassium and sulphur

These can both be provided, at the same time, by using sulphate of potash. Virgin jungle soils have better reserves of potassium than jungle soils that have been used for growing tea. Patana soils are generally more deficient in potassium than jungle soils. When applying urea, the amount of K₂O to use should probably be at least 40 per cent of the quantity of nitrogen applied. For a soil very deficient in potassium, equal amounts of K₂O & N may be needed. Grass managed under a "cut & carry" system will need more potassic fertilizer than if grazed, unless all the excreta from the animal house, is returned to the pasture.

(d) Calcium and magnesium

These can be conveniently provided by using slaked dolomitic lime which contains about 29 per cent CaO and 20 per cent MgO. An appropriate amount to apply would be 500 lb. /ac./an., but if large quantities of urea are being used, more dolomite may be needed. Hypomagnesemia in the cattle is probably the first indication that not enough dolomite is being applied.

Dolomite and urea should not be applied together because they will react chemically and the nitrogen in the urea will be lost as ammonia. A good time to apply dolomite is during the inter-monsoonal period. Probably the most convenient way to provide all the elements listed above is to use dolomite lime once a year and to apply, every two months, i.e., after each third grazing, 152 lb./ac. of a fertilizer mixture made up as follows :—

<i>Fertilizer</i>	<i>Amount</i> (lb.)
Urea (46%N)	500
Conc. superphosphate (42%P ₂ O ₅) ..	170
Sulphate of potash (48%K ₂ O) ..	240
Total for year p.ac.	910

(e) Minor elements

These are not normally applied each year because they are needed in lesser amount than the ones already discussed. They are, nevertheless just as important. In the wet-montane zone of Ceylon, an application of a minor-element mixture once in three years should be adequate, but the frequency with which it should be applied will depend largely upon the quantities of the major elements, such as N, P, K, Ca, etc., being used.

It is very important that minor elements be used in the proper proportions otherwise an imbalance in the amounts of nutrients in the herbage can occur and in consequence a serious health hazard to stock develop. For example if the content of copper in the soil is marginal, as it often is on soils of high organic content, an application of molybdenum alone would induce an acute deficiency of copper in both soil and pasture herbage and animals will scour badly and develop a condition known as teart. But the omission of molybdenum from a minor-element mixture is unlikely to cause any serious nutritional imbalance.

Whilst the application of minor elements may not appear to be having much effect upon the quantity of grass produced, their regular use is probably justified on the ground of maintaining adequate amounts of various minor elements in the herbage that are essential for proper physiological functioning of both plants and the animals that feed upon them.

A general recommendation for a minor element mixture to use is as follows:—

<i>Fertilizer</i>	<i>Amount</i>
Copper sulphate ..	.. 7 lb. p.ac.
Zinc sulphate ..	.. 7 lb. p.ac.
Borax* ..	.. 10-20 lb. p.ac.
Ammonium molybdate ..	.. 2 ounces p.ac.

*Annual Application may be necessary.

(f) Animal manure

Since as much as 75 per cent. of the nitrogen, 70 per cent. of the phosphorus and potassium and a considerable proportion of the minor elements ingested in feed and animal licks, are voided in the excreta, this is a valuable fertilizer. However, its composition will depend upon the nature of the material ingested.

Some idea of the value of animal excreta may be gathered from Table 4. It will be noted from table No. 4 that most of the nitrogen, potassium and sulphur excreted is in the urine whereas the largest proportion of the phosphorus, calcium and magnesium will be found in the dung. Thus to obtain the full value of minerals excreted in animal houses both the dung and the urine should be used. A common practice on dairy farms is to wash both into a pit and then use the slurry as a liquid manure. The amount that can be saved on expenditure for artificial fertilizer will obviously depend upon excreta available and this upon the time that the animals spend at the milking shed.

(ii) *Grazing and mowing, etc.*

Kikuyu branches freely near the cut ends of the stolons and this process goes on after each grazing. If the old stems are not grazed or mown they tend to become very fibrous and unpalatable. Therefore, keeping the grass short and leafy is important for the maintenance of high animal production.

The recommended procedure is to graze very heavily for a short period and then allow the grass to grow to a height of about six inches before again grazing it in a similar manner. Experience at Ambawela indicates that, in the wet zone, a stocking rate of about two milkers per ac. and a recovery period of about thirty days between grazing is appropriate. To achieve this the grazing areas should be subdivided into thirty-two paddocks and each grazed for a day, by the full milking herd in rotation. Unconsumed herbage is then cleaned up by a herd of followers consisting of young stock or dry cows, grazing for one day. An alternative arrangement would be to subdivide into nine paddocks and graze the milking animals on each for two days in rotation and follow them with dry stock grazing for two days. Electric fences are quite suitable for subdivision. After grazing the dung should be spread to prevent the development of rank patches of growth. During those times of the year when the grass is growing much faster than usual the grazing rotation could be shortened by withdrawing a portion of the total area from grazing and cutting the herbage from this for silage or hay. This conserved fodder can be fed back when the growth rate of the pasture is below par, such as during dry or frosty periods. Unless dung and urine are collected and returned to paddock it is better to feed the conserved herbage to the

KIUYU GRASS—AND ITS VALUE IN THE MONTANE REGION OF CEYLON

TABLE No. 4.—Composition of excreta, quantity of mineral matter voided by a cow during a period of twelve months and equivalents in artificial fertilizer. (8)

Excrement fraction	Dung		Urine		Total Dung and Urine (lb.)	Fertilizer equivalent (lb.)
	(%)	(lb.)	(%)	(lb.)		
Water	84.00	18,390.0	92.00	10,074.0	28,470.0	—
N	0.30	65.7	0.80	87.6	153.3	Urea, 319
P ₂ O ₅	0.25	54.7	Trace	—	54.7	Concentrated superphosphate, 130
K ₂ O	0.02	4.4	1.35	147.8	152.2	Sulphate of potash, 317
Ca O and Mg O	0.40	87.6	0.15	16.4	104.0	Dolomite, 400
SiO ₂	0.05	10.9	0.15	16.4	27.3	Ordinary superphosphate, 136
Total Ash	2.40	525.6	2.00	219.0	744.6	—
Total excrement from 1000 lb. animal	—	21900	—	10950	32850	—

animals in the paddocks than in the shed. Running a heavily weighted spike-harrow over the pasture, immediately after it has been grazed, will drag most of the old stolons into an upright position and pull out many of them. Those that remain upright could then be removed, by mowing. Such treatment will promote the regrowth of fresh leafy material.

(iii) *Renovation*

If pastures have been under-utilized because of insufficient grazing, become sod bound and the soil become covered with a dense mat of stoloniferous growth, they will need special treatment to restore them to their former productivity. Mowing or burning to remove the mat of stolons is the first step as heavy grazing is generally ineffective in removing the "micro-forest" of stalky material that has accumulated. The next step is to drastically cultivate the ground to break up the dense matrix of rhizome growth. Cultivation cannot be too severe. Mild disturbance of the soil is useless.

After cultivation a good opportunity presents itself for the introduction of associate species that normally could not establish themselves in competition with the kikuyu. These may be either planted or the seed sown and covered to promote germination. A list of species that might appropriately be introduced is given later in this article.

(iv) *Conservation of surplus pasture herbage*

Whatever method is used, the feeding value of the product will depend primarily upon the stage at which the herbage is cut and harvested. If cut after thirty days regrowth its quality should be very good, whereas when cut after 42 days it will be relatively poor, however, this may be compensated for by the greater ease of collection. If possible the shorter grass should be cut and collected.

Hay could be made during dry-sunny conditions but because of the uncertain weather in the montane-zone making silage would be a safer procedure as this can be undertaken even when it is raining. If the weather is dry enough for the grass to be wilted for half a day after cutting, it can be put into a stack, trench or tower silo without any additive. But if very succulent, and/or wet, it is desirable to add a readily fermentable material to promote the formation of lactic acid which is necessary to preserve it from bacterial decomposition. Cows readily eat kikuyu-grass silage and using this is considerably cheaper than feeding concentrates to maintain milk production during lean periods.

ASSOCIATE SPECIES

(i) *Companion grasses*

Since no grass is perfect in all respects, it is desirable to have several kinds growing together so that each one may complement the others.

Probably the greatest weakness of kikuyu is its inability to grow strongly when the mean weekly minimum temperature falls below 52°F, but fortunately this circumstance only occurs for a short time in the montane-zone of Ceylon.

An ideal arrangement would be to have companion species with different growth rhythms chosen so that, at any one time, there would always be at least one species growing vigorously.

Species, that possess many desirable features, worth trying as companion species, with kikuyu are as follows :—

Botanical name	Common name
<i>Brachiaria ruziziensis</i>	Congo signal grass
<i>Bromus cartharticus</i>	Prairie grass
<i>Cenchrus ciliaris</i>	Buffel grass
<i>Dactylis glomerata</i>	Cocksfoot grass
<i>Festuca arundinacea</i>	Tall fescue grass
<i>Lolium perenne</i>	Perennial rye grass
<i>Panicum antidotale</i>	Blue panic grass
<i>Panicum coloratum</i>	Coloured guinea grass
<i>Panicum maximum</i>	Guinea grass
<i>Paspalum dilatatum</i>	Paspalum or golden-crown
<i>Paspalum notatum</i>	Bahia grass
<i>Paspalum plicatulum</i>	Plicatulum grass
<i>Paspalum wettsteinii</i>	Broad-leaf paspalum grass
<i>Phalaris arundinacea</i>	Reed-canary grass
<i>Phalaris tuberosa</i>	Harding grass
<i>Phleum pratense</i>	Timothy grass
<i>Setaria spaciolata</i>	Kazongula setaria grass

There are many varieties and cultivars of each of the above species. Since the cost of introducing them can be high, only limited areas should be tried until their suitability or otherwise has been fully determined.

Legumes for nitrogen

Legumes are commonly grown with grasses to provide them with cheap nitrogen, but in the montane-zone of Ceylon, as yet, there is no certainty that they could provide the full nitrogen requirement for kikiyu grass. Unfortunately if a nitrogenous fertilizer is used to supplement that provided by the legumes, this usually has the effect of lessening the amount supplied by the legume, because its nitrogen-fixing activity varies inversely according to the amount of soil nitrogen present. If both grass and legume species are to be maintained in a mixed pasture it needs to be managed in quite a different way to one consisting only of grass. Further, one legume will probably need a different kind of management to another. It is mainly for the above reasons that, when nitrogenous fertilizer is available, legumes are not always recommended for association with kikuyu grass. However, if leguminous species are to be tried as a source of nitrogen it is essential that their seeds be properly inoculated with the correct strain of bacteria, at sowing time. As various cultivars of each species are available, advice should be obtained before ordering seed.

It is much easier to introduce leguminous species at the time of planting kikuyu than after it has become established, for then drastic cultivation or the use of a grass dessicant is necessary to give the legume seedlings an opportunity to compete successfully with the established grass.

Leguminous species worth trying, for various environments where kikuyu could be grown, are as follows :—

<i>Botanical name</i>	<i>Common name</i>
<i>Desmodium caninum</i>	Kaimi clover
<i>Desmodium intortum</i>	Green-leaf Desmodium
<i>Desmodium uncinatum</i>	Silver-leaf Desmodium
<i>Lotononis bainesii</i>	Lotononis
<i>Parochaetus communis</i>	Violet trefoil
<i>Phaseolus atropurpureus</i>	Siratro
<i>Trifolium dubium</i>	Suckling clover
<i>Trifolium fragiferum</i>	Strawberry clover
<i>Trifolium pratense</i>	Red clover
<i>Trifolium ruepellianum</i>	Burchells red clover
<i>Trifolium semipilosum</i>	Kenya white clover
<i>Trifolium subterraneum</i>	Subterranean clover

KIKUYU GRASS—AND ITS VALUE IN THE MONTANE REGION OF CEYLON

PESTS AND DISEASES

Generally, kikuyu is remarkably free from pests and diseases and so far, none causing any appreciable damage have been noted in Ceylon.

In Australia probably the most serious pest is the kikuyu bug (*Halticus chrysolepsis*) which is wide-spread on the Atherton tableland. It causes mottling and bunching of the leaves.

Various malformations and discolorations of foliage can develop if nutrient imbalance occurs. Signs of deficiencies of some of the elements are as follows:—

Nitrogen—Yellowing of foliage, worse on oldest leaves.

Phosphorus—Gray-green foliage, all leaves.

Potassium—Tip and marginal leaf scorch.

Calcium—Discoloration of leaf and main vein causing collapse of leaf.

Magnesium—Interveinal yellow striping.

Boron—Withering of the tips of oldest leaves.

Unfortunately several deficiencies often occur together making positive identification of each quite difficult.

Frost damage may be mistaken for a nutritional disorder.

ERADICATION FROM CULTIVATION AREAS

Because of its aggressive creeping-habit kikiyu grass is more difficult to eradicate than bunch grasses are. However there need not be any cause for alarm if it is introduced on to tea estate as for years it has been growing on the road-sides adjoining tea plantations, in the montane zone, and has not become a serious pest. If the tea bushes are healthy and produce a good canopy, to block off the light, grass plants cannot grow satisfactorily beneath them, but if the tea is old and sparse kikuyu might then invade the plantation and need digging out and/or spraying with a weedicide. Various formulations are available for this purpose such as TCA, CMU and Dalapon (7).

If land under kikuyu is needed for rotation crops, a combination of spraying and cultivation is usually effective and best results will be obtained if carried out during dry frosty weather.

USE IN ROTATION

Kikuyu may be used in rotation with vegetable crops to prevent the build up of undesirable insects and diseases. In a few years well-managed kikuyu grass, grazed by milking cows, will not only provide additional income for the land holder but also restore the fertility of worn-out land.

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