Some important grassland types in Surinam

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Summary

The livestock population of Surinam is almost entirely dependent on the indigenous grasslands for its roughage supply. About 35 % of the livestock pastures are fenced grasslands, the remainder consisting of fallow fields (*e.g.* paddy fields), herbaceous swamps and ditches.
As vast areas of grassland are composed of plant societies with a single pure dominant it is attractive to base the grassland classification on dominancy, especially as there are great interspecific differences in yield and nutritive value.
This enables a number of grassland types to be clearly distinguished on clay and sandy soils. Transitional types are usually found on moist clay and loamy soils.

1. Introduction

The livestock population of Surinam derives practically its entire roughage supply from the natural grasslands in the coastal region, the acreage of improved grasslands still being very small. Some idea of the present sources of roughage may be obtained from data of the agricultural census in 1962 on the number of livestock and land use. This data is given in TABLE 1.

TABLE 1. The number of livestock, the acreage of fenced grasslands and paddy fields in the various districts (data agricultural census, 1962)

District	Number of livestock	Grassland (ha)	Main-crop paddy (ha)
Commewijne	3319	446	2116
Coronie	624	72	220
Marowijne	287	152	46
Nickerie	5402	1539	13995
Saramacca	2502	312	2538
Surinam	24771	3771	5651
Whole country	36905	6292	24566

This TABLE shows that the acreage of fenced grasslands is very small compared to the livestock population. Moreover, a considerable part of the grasslands in the districts of Coronie and Nickerie consists of the less productive commons. Paddy fields also contribute to the roughage supply. The paddy fields are fallow from the end of October to mid-April, in which period almost half of the acreage is grazed.
The situation in the Surinam district is particularly interesting. It provides the fresh-milk requirements of the capital Paramaribo; about 70 % of the Surinam livestock

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population is found in this area. If the stocking capacity of the grassland is put at 2.0 per ha and that of the paddy fields at 0.5 per ha, the grassland and paddy-field acreage is sufficient for 10,000 head of cattle at most. The remaining livestock — about 14,000 head of cattle — obtains its roughage supply from the herbaceous swamps, fallow fields, roadsides and ditches. In many cases this may lead to a temporary or permanent shortage of forage.
This clearly shows the great importance of the natural grasslands for animal husbandry in Surinam. Sufficient knowledge of the botanical composition of these grasslands may contribute to an optimum utilization of this forage source. Before the most important grassland types are discussed, the climate and soil will be briefly described.

2. Climate

A tropical rain climate prevails in the coastal region of Surinam. The average annual temperature at Paramaribo is 27.1° C. The average monthly rainfall (in mm), measured at the stations in the most important livestock centres — Nieuw Nickerie and Paramaribo — is given in TABLE 2. This TABLE clearly shows that rainfall is not

TABLE 2. Average monthly rainfall (in mm) in Nieuw Nickerie and Paramaribo

	J	F	M	A	M	J	J	A	S	O	N	D	Total
Nieuw Nickerie ..	195	109	112	172	249	318	265	149	59	56	77	173	1934
Paramaribo	215	161	192	228	313	302	232	161	79	78	120	211	2292

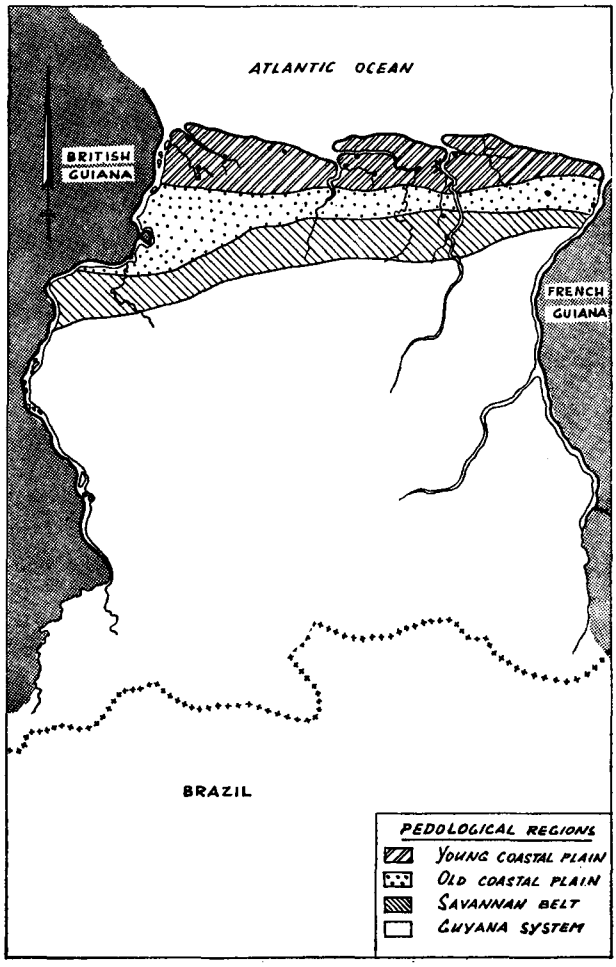
evenly distributed over the year. There are four separate seasons, *viz.* the long rainy season from March 16 to August 1, the long dry season from August 1 to December 1, the short rainy spell from December 1 to February 1, and the short dry spell from February 1 to March 16. The long seasons are fairly reliable, unlike the short spells, which vary considerably (OSTENDORF, 1955).

3. Soil

As mentioned above, animal husbandry is only practised in the coastal region, where the following two formations may be distinguished (see FIGURE).

1. *The Demarara formation* (Young Coastal Plain; 1,700,000 ha) consists of about 80 % of swamps with a clay soil. These swamps are almost 1 m below Surinam standard level which is about 2.07 m above the mean sea level. They are divided into swamp forests and herbaceous swamps, depending on the vegetation. There are ridge bundles in the central and eastern part of the Young Coastal Plain. These ridges are usually composed of fine sand and are situated up to 1½ m above swamp level. The dry sandy soil of the highest ridge parts changes gradually or abruptly into swamps via zones of moist sandy soil and sandy loam. The original vegetation of these ridges is evergreen seasonal forest (VAN DER EIJK, 1957).
2. *The Coropina formation* (Old Coastal Plain; 400,000 ha) is situated about 1—7 m above Surinam standard level. There are two important landscapes, *viz.* the old offshore-bar landscape and the old sea-clay landscape. Most of the soil of the former landscape is fine sand and loamy sand. The sandy soils may be podzolized on the

FIGURE. Pedological regions



Source: VAN AS and TIGGELMAN, Developments in Surinam agriculture. *Neth. J. agric. Sci. 10,* 4: *Fig.* 3 following p. 256.

plains. In the old sea-clay landscape the soil consists of silty loam and silty clay. However, the grassland acreage in this landscape is small. The original vegetation of the Old Coastal Plain is mixed evergreen seasonal forest and savanna woods on the bleached sands. Both landscapes are divided by erosion gullies consisting of clay or peat.

The Zanderij formation (Savannah Belt; 1,200,000 ha) consists of coarse-sandy soils and coarse-sandy loam soils; it is situated south of the Old Coastal Plain. About 93 % of this area is wooded, the remaining 7 % being plains covered with grasses and

grasslike weeds, sometimes shrubs as well. Animal husbandry in this region is limited to experiments.

Beyond these three formations the interior is mostly covered with forests, although there are another 60,000 ha of open savanna near the Brazilian border.

4. Grassland types

Having regard to the extensive animal husbandry in Surinam, grassland research has a practical bias. The study of the botanical composition of the natural grasslands was usually conferred to recording the species and estimating the area covered by the most important plant species. At the same time notes were made on the soil, drainage, use, *etc.* In some cases, however, the sward of more or less homogeneous patches was analysed in greater detail. For this purpose quadrats of ½ sq. m or 1 sq. dm were laid down in the herbage 20 to 100 times per ha along the diagonals. The plant species occurring in the quadrat were recorded and their percentage of cover estimated. From this we were able to estimate the quantitative distribution of the grassland species.

As vast areas of grassland are almost covered by a single species, we prefer classifying the grasslands according to dominant plant species, especially as the grass species differ extensively in yield and nutritive value. The most important grassland types on clay and sandy soil can be found from the plot-analysis data, which is discussed below. Transition types frequently occur on the loamy soils; this is also due to the parcelisation of the fields.

4.1. Clay soil

The natural vegetation of the clay soils consists of marsh forests, herbaceous swamps and swamp forests. The climax vegetation is marsh forests, while the presence of herbaceous swamps is mainly due to burning. The natural grasslands on these soils originated from deforestation, drainage and grazing. These grasslands are divided into the following groups, depending on drainage and use: – herbaceous swamps, paddy fields, wet clay grasslands and dry to moist clay grasslands.

4.1.1. *Herbaceous swamps*

During the dry season, when the productivity of the grasslands is low, cattle graze in the neighbouring swamps. In some cases a swamp is fenced and used as a common. LINDEMAN (1953) divided the herbaceous swamps into the following six types: – 1. *Eleocharis mutata* 2. *Typha angustifolia* — *Cyperus articulatus* 3. *Leersia hexandra* 4. *Cyperus giganteus* — *Typha angustifolia* — *Scleria eggersiana* 5. *Rhynchospora corymbosa* with undergrowth of *Leersia hexandra* or ferns 6. *Lagenocarpus guianensis* — other *Cyperaceae*. He noticed, however, that the name-giving species within types 2 and 4 can dominate locally. This was readily confirmed when the swamps were reclaimed in connection with the Wageningen Project. For agricultural purposes, *e.g.* valuation of paddy soils, reclamation method and valuation of roughage, a classification based on the dominance of the following plant species seems more suitable: –

Grasses:	*Leersia hexandra*
	Panicum grande

Grasslike weeds:	*Cyperus articulatus*
	Cyperus giganteus
	Eleocharis interstincta
	Eleocharis mutata
	Fuirena umbellata, F. robusta
	Lagenocarpus guianensis
	Rhynchospora corymbosa, R. gigantea
Other plant species:	*Blechnum indicum*
	Typha angustifolia

The above-mentioned species may occur in fairly pure stands on smaller or larger areas. The species *Leersia hexandra, Cyperus articulatus, Cyperus giganteus, Eleocharis mutata* and *Typha angustifolia* may cover vast areas. East of Coronie there is a vast complex of *Cyperus articulatus. Typha angustifolia* only dominates in the lower parts. North of the plantation "Marienbosch" (Commewijne) there are hundreds of hectares of swamp overgrown with *Leersia hexandra.* Swamps covered with *Eleocharis interstincta* are chiefly found between the ridges. Scores of hectares of this grasslike weed are found in the "Granmanswamp" North of Lelydorp.

The cause of these differences in the vegetation has not yet been explained. Different vegetation types occur under apparently similar ecological conditions, and are often separated at random. DE WIT's (1960) investigations did not establish any connection between these types and soil fertility. On the other hand, there is a connection between the salt content of soil and water and the vegetation type. Thus, *Eleocharis mutata* is particularly common near the coast. *Cyperus articulatus* and *Typha angustifolia* occur in the next zone of brackish water. The latter species also occurs in fresh-water swamps, where *Cyperus giganteus* may also dominate. According to LINDEMAN (1953) and DE WIT (1960) the depth of the pegasse layer also influences the botanical composition of the herbaceous swamps. The water table and its fluctuations during the year will affect the composition as well, but this can only be determined after an investigation spread over many years.

The *Leersia hexandra* type is undoubtedly the most important for roughage supply. If the coarser plant species in the *Cyperus giganteus* and *Typha angustifolia* swamps are crushed several times by a brushcutter, such nutritive grasses as *Leersia hexandra, Luziola spruceana* and *Sacciolepis striata* will become dominant. However, due care should be taken with grazing, as otherwise undesirable plant species may spread. The remaining swamp types are useless as a source of roughage. Even water buffaloes, which are not particular about the kind of forage, will live under marginal conditions in these swamps. These areas can only be used for grazing purposes provided the drainage is improved and favoured grasses are planted.

4.1.2. *Paddy fields*

After the paddy has been harvested in October the paddy fields lie fallow until the following planting time (April). It is during this period that the greater part of the paddy fields is grazed. 104 plots (selected by a pedologist) were analysed in order to study the vegetation of these fallow fields. Complete records of species were made, with notes on the area covered by the most important species. The percentage distribution of the dominant plant species over the various paddy fields can be calculated from this data, as is shown in TABLE 3. A distinction was drawn between the districts of Surinam and Nickerie. In the former the water supply is entirely dependent on rainfall. About 75 % of the paddy fields are grazed here. In the

TABLE 3. The frequency of dominancy of a plant species in the various paddy fields, expressed as a percentage of the number of plot analyses

District:	Suriname		Nickerie
Soil type:	sand, loam sandy clay	clay	clay
Number of plot analyses:	33	37	34
Grasses			
Acroceras zizanioides	1.5		
Echinochloa crus pavonis			14.7
Eriochloa punctata			2.9
Hymenachne amplexicaulis	12.1	2.3	23.5
Ischaemum rugosum	1.5	0.9	11.8
Leersia hexandra		0.9	
Paspalum conjugatum			2.9
Paspalum cf *melanospermum*	22.7	2.7	32.4
Grasslike weeds			
Eleocharis caribaea		2.7	
Eleocharis flaccida		2.7	
Eleocharis interstincta	1.5	2.7	
Fimbristylis miliacea	31.8	70.3	2.9
Rhynchospora cyperoides	1.5	2.7	
Rhynchospora viridi-lutea		2.7	
Herbs			
Aeschynomene sensitiva		2.7	
Commelina nudiflora		2.7	
Jussieua spp.	1.5		
Lindernia crustacea	3.0		
Melastomaceae	1.5		
Nymphoides humboldtianum	18.2	4.0	
Oldenlandia lancifolia			5.9
Piriqueta cistoides			2.9
Tonina fluviatilis	3.0		

Nickerie district irrigation water is available. Less than half the paddy fields are grazed. TABLE 3 shows that *Fimbristylis miliacea* is the most important component of the vegetation on the fallow fields in the district of Surinam. Dominancy of this grasslike weed is generally due to the inadequate water supply in this district. This was confirmed in pot-culture experiments with varying water tables, in which the growth of *Fimbristylis miliacea* was clearly reduced by a 10 cm-deep layer of water (DIRVEN and JONGE POERINK, 1955). Livestock favours this grasslike weed in its early stage, but its nutritive value later decreases. On lighter soils the importance of *Fimbristylis miliacea* decreases, *Hymenachne amplexicaulis, Paspalum melanospermum* and *Nymphoides humboldtianum* being more in evidence. Owing to its prostrate habit and slight productivity the latter aquatic species is of no interest as forage.

In the Nickerie district the vegetation of the fallow fields mainly consists of grasses, with a few grasslike weeds and herbs. The annual grasses *Echinochloa crus pavonis* and *Ischaemum rugosum* dominate on the non-grazed paddy fields, while the perennial *Hymenachne amplexicaulis* dominates on grazed paddy fields. *Paspalum melanospermum* is not particular with regard to grazing.

Most interesting are the shoots of *Brachiaria purpurascens* (Para grass) that spring up

after the paddy harvest on the clay soils in the Saramacca district. It has been shown that the rooted stem parts of this enables it to survive the paddy season. The same applies to *Hymenachne amplexicaulis,* although this grass also survives by means of seed. If these species are planted in paddy fields with an adequate water supply, the productivity of these vegetations will undoubtedly increase (DIRVEN, DULDER and HERMELIJN, 1960).

4.1.3. *Wet grasslands*

If reclaimed swamps, used as paddy fields for some years, are abandoned, aquatic species like *Echinochloa polystachya, Hymenachne amplexicaulis* and *Leersia hexandra* may become dominant. These grasses are usually very nutritive (DIRVEN, 1963). This is also true of *Hymenachne donacifolia* and *Luziola spruceana,* which likewise grow in a wet habitat. These two grasses, however are usually patchily distributed in other swards. Obviously the aquatic species are also found in creeks and ditches, where they are usually cut and barn-fed. Of the grassland types mentioned, *Leersia hexandra* and *Hymenachne amplexicaulis* are the most important and cover vast areas.

Other plant species only occur to a moderate extent in the *Leersia hexandra* type, as this species forms a solid mat with an almost 100 % coverage. Such plant species as *Panicum mertensii, Cyperus giganteus, Montrichardia arborescens, Neptunia plena* and *Typha angustifolia,* which occur in herbaceous swamps of this type, disappear completely. Instead *Fimbristylis miliacea, Nymphoides humboldtianum* and *Jussieua* spp. are frequently found. These species are indicators of the former use of these soils. The area covered by *Leersia hexandra* may decrease considerably as a result of grazing. If drainage is improved at the same time, infections of *Paspalum densum* may occur. Livestock does not favour this tuft-forming species and in an open sward it may spread to such an extent as to become dominant. This kind of grassland can only be improved by ploughing up.

The impression gained is that the soils on which the *Hymenachne amplexicaulis* type occurs are lighter than those associated with the *Leersia hexandra* type. The coverage of this type is smaller and on the plots investigated it averaged 70 % within a variation of 45—95 %. About 80 % of the herbage of this type consists of *Hymenachne amplexicaulis.* Associated species are *Acroceras zizanioides, Leersia hexandra, Panicum laxum, Paspalum distichum, Eleocharis interstincta, Fimbristylis miliacea, Alternanthera sessilis, Jussieua* spp. and *Nymphoides humboldtianum.* Of these plant species *Paspalum distichum* is especially appreciated as a fodder plant.

Paspalum vaginatum dominates near the coast on soils regularly flooded by sea water. This grass frequently occurs together with *Eleocharis mutata.* This grassland type has a very low nutritive value.

4.1.4. *Dry to moist grasslands*

Although the drainage of clay grasslands may be considerably improved by ditches and trenches, the high clay ($< 2\ \mu$) content of these soils prevents rapid drainage of rainwater. This means that in the rainy season the sward is continuously damaged by trampling. It is therefore difficult to separate dry from moist clay grasslands.

The dry clay grasslands mainly consist of *Paspalum conjugatum. Cynodon dactylon* only dominates in patches on the smaller areas. When drainage is improved *Paspalum conjugatum* penetrates the fields from the ditch and trench sides and becomes dominant. In such cases 90 % of the sward consists of this species. Frequently occurring plant species in the *Paspalum conjugatum* type are: *Acroceras zizanioides, Cynodon*

dactylon, Leersia hexandra, Panicum laxum, Cyperus luzulae, Fimbristylis miliacea, Torulinium ferax, Asclepias curassavica, Jussieua spp. and *Solanum* spp.
Cattle does not favour *Paspalum conjugatum* in a fresh condition; the uptake improves after cutting and wilting. The nutritive value of this species is also low, and the digestibility of the crude protein is strikingly low. Understocking may stimulate *Sporobolus indicus* and *Sporobolus poiretti* in this grassland type. The two latter species are only consumed in the young stage; they spread rapidly by seed. Owing to the many inflorescences of these *Sporobolus* species the grassland has a more or less dry appearance. A fairly pure community of *Paspalum virgatum* may be found on well-drained clay soil. This grass is also consumed in the young stage only.
The grasslands found on moist clay soils are mainly transitional types between the wet and dry clay grasslands. This is due to the micro relief of these soils. They consist of hummocks with a diameter of some sq. dm, separated by gullies. As a result there is no pure dominance of a single species (see TABLE 4). *Axonopus com-*

TABLE 4. The botanical composition of some moist clay grasslands, expresed as a percentage of the total area covered

	Examples		
	1	2	3
Grasses			
Acroceras zizanioides	0.6		
Axonopus compressus	1.3	+	2.4
Cynodon dactylon	3.2	0.5	3.7
Hymenachne amplexicaulis		0.2	5.1
Ischaemum rugosum			0.7
Leersia hexandra	2.5	6.6	5.8
Panicum laxum		4.5	3.5
Paspalum conjugatum	10.6	4.2	6.4
Sporobolus indicus; Sporobolus poiretti	12.4	1.6	0.9
Legumes			
Aeschynomene sensitiva			0.2
Alysicarpus vaginalis	0.3		0.1
Desmodium triflorum	1.7	4.1	10.9
Grasslike weeds			
Cyperus luzulae	4.2	0.2	2.5
Eleocharis interstincta		0.1	0.2
Fimbristylis annua	+		0.6
Fimbristylis miliacea	2.5	10.5	6.7
Scleria sp.	0.5		
Torulinium ferax		0.1	0.2
Herbs			
Borreria sp.	0.3	0.6	0.1
Commelina nudiflora		+	
Hyptis atrorubens	+		
Jussieua spp.		0.6	0.6
Phyllanthus urinaria	+		
Pterolepis glomerata		0.1	
Vernonia cinerea		0.1	
Wedelia trilobata	11.7	10.3	10.2
Bare soil	48.2	55.7	39.2

pressus, Cynodon dactylon, Panicum laxum, Paspalum conjugatum, Sporobolus spp., *Cyperus luzulae* and *Desmodium triflorum* grow on the hummocks, while *Hymenachne amplexicaulis, Leersia hexandra, Fimbristylis miliacea* and *Jussieua* spp. are found in the gullies. *Wedelia trilobata* also grows on the hummocks. The latter Composita is very aggressive, is not grazed by livestock, and if not actively controlled will oust the other species. Scores of hectares are covered by a solid mat of this weed.
As regards quantity and quality, the sward of dry and moist clay soils offers few possibilities for roughage supply. In this respect wet clay grasslands are preferable. Drainage of these grasslands, without simultaneous planting cultivated grasses, evidently leads to less favourable results.

4.2. Sandy soil

The botanical composition of grasslands on sandy soil in the Old Coastal Plain closely corresponds to that on the sandy ridges in the Young Coastal Plain, an exception being the grasslands on ground-water podzols, which are treated separately.

4.2.1. *Sandy ridges*

After deforestation by cutting and burning, maize is mostly grown on these soils, sometimes followed by bananas. Most of the weed vegetation in these crops consists of grasses. The most important species are: the annuals *Digitaria horizontalis, Digitaria microbachne, Eleusine indica* and *Paspalum melanospermum* and the perennials *Panicum laxum,* and *Paspalum conjugatum.* This vegetation may vary considerably from place to place, but *Digitaria horizontalis* is most prominent. After harvest, these fields are grazed and the annual grasses are eventually eliminated. This is when *Axonopus compressus* becomes important. The seeds of this species are spread by the droppings of the grazing cattle.
Dependent on the soil type, a sward is formed with a varying *Axonopus compressus* cover (see TABLE 5). Vast areas covered by this grassland type are found on the dairy farms near Paramaribo. Although not very productive, *Axonopus compressus* is much appreciated by the farmers because of its mat-forming property and nutritive value. TABLE 5 shows that the conditions on the dry sandy soil are optimal for the mat-forming of *Axonopus compressus,* so that other plant species cannot establish themselves in these parts. The relatively high percentages of *Cynodon dactylon* and *Desmodium triflorum* indicate the effective drainage of these soils. *Tonina fluviatilis* only occurs in the rainy season, and dies back in the dry season. This grassland type is not directly fertilized. However, rotational cropping with bananas takes place every five years, the crop receiving a heavy application of farmyard manure (60—100 tons/ha).
On moist sandy soil the coverage of *Axonopus compressus* is considerably lower. *Cynodon dactylon* and *Desmodium triflorum* also decrease, and *Panicum laxum* increases. These are clear indications of the unsatisfactory drainage of these soils. Owing to the poor soil fertility the percentage of *Hyptis atrorubens* is strikingly high. The sward is less solid, as shown by the percentage of bare soil. As a consequence the productivity of this grassland type is considerably less than on dry sandy soil.
The grasslands on such humous sandy soils as those on moist clay soils consist of hummocks and gullies. These hummocks are formed by worm activity. Aquatic species such as *Hymenachne amplexicaulis, Leersia hexandra* and *Nymphoides humboldtianum* occur in the gullies. The vegetation of the hummocks is chiefly formed by the grasses *Panicum laxum* and *Axonopus compressus,* with *Paspalum orbiculatum*

TABLE 5. Botanical composition of grasslands on the different soil types of the sandy ridges, expressed as a percentage of the total area covered

	dry sandy soil	moist sandy soil	sandy loam soil
Grasses			
Acroceras zizanioides		+	
Axonopus compressus	69.8	27.3	14.1
Cynodon dactylon	3.7	0.3	+
Hymenachne amplexicaulis			+
Leersia hexandra		+	0.1
Panicum laxum	+	4.5	23.4
Paspalum conjugatum		0.5	+
Paspalum multicaule			0.2
Paspalum orbiculatum		+	2.4
Sporobolus indicus		+	
Sporobolus poiretti		+	
Legumes			
Alysicarpus vaginalis	0.6	+	+
Desmodium triflorum	7.6	3.1	0.1
Grasslike weeds			
Cyperus articulatus			+
Cyperus luzulae	+	0.5	+
Cyperus sphacelatus	+		
Dichromena pubera	+	+	
Eleocharis sulcata	+		2.2
Fimbristylis annua	0.3		
Fimbristylis miliacea		0.1	0.2
Kyllinga pumila	4.5	+	0.3
Pycreus polystachyus	0.4		+
Rhynchospora candida	+	0.7	
Herbs			
Alternanthera sessilis			+
Asclepias curassavica	+		+
Beyrichia ocymoides	+	0.2	+
Hydrolea spinosa			+
Hyptis atrorubens	+	5.6	+
Jussieua sp.		+	
Lindernia crustacea	+	+	+
Nymphoides humboldtianum			+
Oldenlandia lancifolia var. *latifolia*		+	
Phyllanthus urinaria		+	
Polygonum hydropiperoides			+
Pterolepis glomerata	+	+	+
Solanum stramonifolium	+	+	
Tonina fluviatilis	1.5	+	0.3
Bare soil	11.6	57.2	56.7

as an associate species. The latter grass is always found on the hummocks, but not usually to any great extent.

The management of these grasslands is inadequate and limited to weeding once or twice a year. The troublesome weeds are: *Asclepias curassavica, Dieffenbachia seguine, Solanum* spp. and *Syzygium cumini.* Understocking may stimulate *Sporobolus indicus*

and *Sporobolus poiretti*. These species are not grazed in the older stage, and this considerably decreases the quality of the sward.
The grasslands on the sandy ridges mainly consist of the above-mentioned *Axonopus compressus* type. The following types are also found on the dry sandy soils: –

1. *Ischaemum* sp. type. Near "Welgedacht A" some scores of hectares are covered by this grass. *Ischaemum* sp. is cut as well as grazed.
2. *Stenotaphrum secundatum* type. This grass grows on the margin of the beach. As a pasture grass it is known from one habitat only, *viz.* the commons at Coronie. During dry years *Stenotaphrum secundatum* is ousted by *Cynodon dactylon*.
3. *Paspalum maritimum* type. This grass grows excellently on exhausted soils. *Paspalum maritimum* is a most aggressive species, owing to its stolons and rhizomes it forms a dense mat, practically excluding all other species. However, cattle do not like to feed on it.

4.2.2. *Ground-water podzols*

The ground-water podzols are characterized by a sandy top soil, a bleached horizon and an indurated horizon. This pan impedes the drainage of these soils so that there is excess water in the rainy season and a shortage in the dry season. The natural vegetation of these soils is savanna wood. After reclamation, maize is grown and cassava as a second crop. As soon as the soil is exhausted the farmer abandons it. The field lies fallow for the next 10—20 years, the vegetation first consisting of fern shoots (*Blechnum indicum*), and afterwards shrubs and secondary woods. Sometimes however, these areas are grazed. Dependent on drainage, the following plant species may dominate: –

Dry	*Paspalum arenarium*
↓	*Andropogon selloanus*
	Hyptis atrorubens
Moist	*Paspalum pumilum*
↓	*Diplacrum longifolium*
Wet	*Xyris jupicai*; *X. macrocephala*

The botanical composition in the fields may vary considerably from place to place depending on drainage. The cattle live under marginal conditions on these grassland types (high mortality). After drainage has been improved, the use of farmyard manure may stimulate *Axonopus compressus* on the dry to moist places. However, if these ground-water podzols are planted with *Tripsacum laxum* (Guatemala grass) immediately after deforestation, reasonable yields can be expected. The dense rooting of this grass will improve the soil at the same time.

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