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Improvement of

# IMPROVEMENT OF GRAZING AREAS IN THE BOMBAY PRESIDENCY.

## CHAPTER I.

### *Introduction.*

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Under the conditions of agriculture which prevail now and are likely to prevail for a long time in the Bombay Deccan the maintenance of satisfactory stocks of cattle for work and milk is likely to be closely related with the presence of sufficient good areas for grazing. "Until the last half century, there were in this Presidency, extensive waste lands such as common grazing grounds, which in good years, at any rate, provided for the village herds a fair quantity of fodder". \* But owing to the demand for land for cultivation of food and commercial crops, which tend at the same time to increase the required number of cattle and to reduce the grazing as well as the production of fodder on the cultivated lands, the area available for common grazing, or for grazing by paying a small fee to a private owner has been reduced in almost every part of the Bombay Presidency. The very salutary old Mahomedan rule which provided that there should be one acre of grazing land to every ten acres of cultivated land, † has largely been forgotten and the areas still available have been and are still being seriously overgrazed, with evil results not only to the cattle, but also to the grazing lands themselves.

The evil effect on the cattle has been considered elsewhere. But the result on the grazing areas themselves is not so frequently referred to or considered. But the consequence of the overgrazing of the areas still available is that many valuable indigenous fodder grasses have become much rarer than was formerly the case, and in some cases they have almost disappeared over large areas. Cattle turned out to pasture naturally eat the more succulent and palatable grasses first, so that in places where cattle in considerable numbers always wander over the available ground as soon as a flush of grass comes each year, the better grasses have less chance than any others of maturing and spreading. The

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\* Keatinge—Note on the Cattle in the Bombay Presidency. Bulletin No. 85 of the Bombay Department of Agriculture, page 139.

† Quoted by Voeleker, Report on the Improvement of Indian Agriculture, page 194

inferior grasses are much less handicapped, and tend to spread at the expenses of the better ones in the existing grazing areas.

We can give two or three striking examples of this process in actual operation in various parts of the Bombay Presidency:

(a) At the Chharodi Cattle Breeding farm in the Ahmedabad District the excellent fodder grasses *Andropogon annulatus* and *Iseilema wightii* were formerly present in large amount over considerable areas of the farm. These are now making relatively poor growth as compared with a number of inferior species, or disappearing entirely, and the area is becoming crowded with hardier and inferior species such as *Eragrostis cynosuroides*, *Chloris pallida*, and *Ischaemum rugosum*. Moreover the yield of grass for grazing per acre is decreasing and the carrying capacity of the land has lessened considerably. Unrestricted grazing (now a thing of the past) is at least a very important factor in the change in the character of the grasses.

(b) At Bankapur in the Dharwar District, only a very few years ago *Andropogon annulatus* was growing very luxuriantly in the fort area, but according to our recent observations, *Andropogon contortus*, a hard and very inferior variety, was becoming very prominent over a large part of the lands and *Andropogon annulatus* has become rare. This is almost certainly due to the effect of unrestricted and close grazing and will probably lead within a very few years to the whole area being occupied by *Andropogon contortus*.

The change in the character of the grass herbage is the best and earliest indication of overgrazing\* and the change is very obvious in the cases quoted, but that the same change is happening all over the Deccan is not doubtful, and it is leading or has led to a decrease in the capacity of the available grazing land to carry cattle. In the present bulletin the author has attempted to show by actual experiments how the herbage of existing *kurans* (or grazing areas) can be improved, how the reseeded *kurans* can be best managed, and how the poor *mal* lands of the Deccan can be utilised for growing better fodder grasses, and hence for producing a larger yield of fodder.

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\* See United States Department of Agriculture Bulletin 71.

## CHAPTER II.

*Attempts to establish Pastures with Single Grasses.*

A good many attempts have been made in recent years in various areas in the Bombay Presidency to establish grazing areas with different single good types of grass. These have in all cases failed, but an account of what has been done in this direction will be useful as an introduction to our experiments.

*Experiment at Surat.\**—The land at Surat consists of typical black cotton soil of Western India, very deep and sticky, and very difficult to drain. With a view to establish pastures of good grasses the land was cultivated and seeds of pure grasses of *Andropogon annulatus*, *Andropogon caricosus*, and *Iseilema wightii* were sown separately in the beginning of the monsoon of 1915, after the soil was thoroughly tilled. A few seedlings appeared but their further progress was checked by weeds and so they failed to become established. Assuming that the failure was due to want of good cultivation, the land was again cultivated more thoroughly in 1916 and the seeds of the same variety were resown. Undesirable weeds and grasses again appeared, but were removed as far as possible. In 1917 the grasses made some progress but still failed to establish themselves and to cover the ground completely. It seemed obvious in fact, that no real success could be achieved unless a mixture of grasses was used which would spread over the whole surface, as these single grasses seemed unable to do.

In 1917, the plot of *Andropogon annulatus* suffered much on account of heavy rains and did not give any yield. In 1918, the plot of *Iseilema wightii* did not thrive well for want of sufficient rain. The plots were again examined in October 1920 and it was found that the plots of both *Andropogon annulatus* and *Iseilema wightii* planted in 1915 were poor and stunted in growth. *Anthistiria ciliata* looked dominant in both the plots. Where a mixture of *Andropogon annulatus* and *Andropogon caricosus* has been planted in 1918, the latter had made an excellent growth and was five feet in height, while the former with its stunted growth served as the bottom crop. The mixture of the two grasses had, in fact, succeeded much better than any of the individual species tried.

*Experiments at Kopargaon.\**—Kopargaon lies on the Deccan (Ahmednagar District) and the farm where the

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\* This work was carried out under the orders and with the supervision of the Deputy Director of Agriculture, N. D., Poona.

experiments were conducted has a black soil about eighteen inches deep under which there is a highly porous *murum* layer. Irrigation is available from canal and thus there is no lack of water, though the district is otherwise generally dry and famine-stricken. With a view to establish a permanent pasture here, one acre of land was sown with *Andropogon annulatus* in 1917 with proper cultivation and irrigation. 12,000 lbs. green grass per acre was the yield obtained in October. In 1918 there were many gaps in the crop which were filled in by transplanting new seedlings from outside. No irrigation was given and the yield was about 8,000 lbs. green grass per acre.

In 1919 there were again fresh gaps in the area and these were not filled in. The yield obtained was 5,000 lbs. per acre. No irrigation was given. In 1920 the plot, kept as it was on rain water only, failed to give any outturn. The growth was so poor as not to be worth cutting.

It is to be noted that the yield instead of increasing decreased year by year and entirely failed in 1920. The reason is not clear, but the interference with the roots produced by the deep and wide cracking of the soil in the hot weather may have had something to do with the gradual deterioration of the plot.

*Experiments at Dharwar.\**—Experiments have been conducted on deep black soil at Dharwar with the same object as mentioned above. *Andropogon annulatus* (marvel grass) and Rhodes grass (*Chloris gayana*) were sown in the beginning of the monsoon of 1916, both singly and with mixtures of maize and jowar (*Andropogon sorghum*) in separate plots. The idea of the mixture was to provide fodder from the cereal crop first and from the grasses later, and the yields (dry) obtained in the first year (1916-17) were as follows:—

Crop.	Yield per acre.		
	Cereal crop.		Grass.
	Grain.	Chaff and fodder.	
	lbs.	lbs.	lbs.
<i>Marvel</i> grass alone ...	...	...	11,064
<i>Marvel</i> grass and maize ...	...	7,016	1,800
<i>Marvel</i> grass and <i>jowar</i> ...	856	2,044	264
Rhodes grass alone ...	...	...	4,160
Rhodes grass and maize ...	...	6,000	2,264
Rhodes grass and <i>jowar</i> ...	888	2,104	280

\* This work was carried on under the orders and with the supervision of the Deputy Director of Agriculture, S. D., Dharwar.

In the second year (1917-18) when the grasses, of course, were alone, they grew poorly, while they seemed to suffer badly from short rainfall between June and September, neither of them seemed to be able to benefit by the abundant rain later in the season.

Rhodes grass kept green for longer than *marvel* grass and grew more quickly, but it was less leafy. *Marvel* grass was cut twice and Rhodes grass four times, during the season, the total yield of green grass being, *Marvel* grass 5,170 lbs., Rhodes grass 3,504 lbs.

In 1918-19 two crops of grass were obtained in each case, in August or September and in November, respectively. The yield was :—

*Marvel* grass—2,100 lbs.

Rhodes grass—4,180 lbs.

This was notoriously a year of short rainfall and though both grasses showed considerable resisting power they gave little yield. Where the planting had been done with mixture with maize and *jowar* the results were far poorer than when the planting was done alone. It may be at once said that in the black soil regions, neither *jowar* nor maize have been found to be suitable nurse crops for any of the perennial grass crops.

*Experiments at Ratnagiri.*—Attempts were continuously made from 1915 to 1919 to establish a permanent pasture of *Andropogon cariccsus var-mollicomus* on high porous land (*varkas* land) in the very heavy rainfall tract near Ratnagiri in the Konkan. The grass grew fairly well for the first two years and afterwards did not show any signs of progress.

*Experiments at Tegur\** (*Dharwar District*).—The Tegur farm lies in the area of fairly good rainfall, but of shallow poor soil in the Western part of the Dharwar District. The object of the trials which are being reviewed was to replace the dominant spear grass (*Andropogon contortus*) with one or more valuable grasses. *Andropogon annulatus (marvel)* was selected as being the most likely for this purpose. The first attempts date from 1914 and in this case by 1920 Burns found that the area was entirely dominated by *Anthistiria ciliata*. Another attempt was made in the monsoon of 1918, when stumps were planted, followed by careful weeding.

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\* This work was carried on under the orders and with the supervision of the Deputy Director of Agriculture, S. D., Dharwar;

In October 1920 the plot was found to be pure with *Andropogon annulatus* though *Setaria glauca* and *Alysicarpus rugosus* made a ground layer at the bottom of the grass.

In the third plot, the land was ploughed and fallowed in 1918 and stumps of *Andropogon annulatus* were put in the monsoon season of 1919. By October 1920, when the main crop was flowering, *Anthistiria ciliata* had already become a prominent weed.

These observations seem to indicate that it is difficult to establish pasture of pure grass in the beginning unless weeding is done, so that a mixture of other grass, either annual or perennial, which serve as a bottom layer and also supply good quantity of green grass in the beginning, would seem to be essential.

All these trials in different places with all the care and trouble bestowed on them prove that it is very difficult to establish grass areas with single good grasses in the conditions of Western India even on excellent soils like the black alluvial land at Surat and the black soils at Dharwar and Kopargaon.

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### CHAPTER III.

#### *Experiments with Grass Lands with mixed Herbage.*

As all experiments, both those recorded in the previous chapter and many others, seem to have shown that under the conditions of Western India it is not easy to establish pastures from single perennial grasses, the question arose as to whether by employing a mixture of various grasses and other plants the desired result could be achieved. Preliminary experiments in 1915 having shown the likelihood of this method being successful, three plots of poor grass land were procured at Ganeshkhind (Kirkee) and a definite attempt was made to improve the vegetation.

The three plots taken may be described as follows:—

I. One acre of land, level, consisting of medium black cotton soil, from eighteen to twenty-four inches deep. The soil of this plot would be considered good, and it contained the following species, those italicised being the most prominent:—

*Andropogon pumilis.*      *Heylandia latebrosa.*  
*Iseilema anthophoroides.*      *Tripogon Jacquemontii.*

<i>Andropogon contortus.</i>	<i>Ischaemum laxum.</i>
<i>Setaria glauca.</i>	<i>Lophopogon tridentatus.</i>
<i>Gracilea Royleana</i>	Zornia diphylla.
Sporobolus diander.	Sporobolus indicus.
Eragrostis bifaria.	Biophytum sensitivum.
Hydrocotyle asiatica.	Indigofera linifolia.
Triumfetta rotundifolia.	Cassia tora.
<i>Bidens pilosa.</i>	Pulicaria wightiana.
<i>Tridax procumbens.</i>	Antihistiria ciliata.
Andropogon annulatus.	Lagasca mollis.

II. Half an acre of land, with a slight slope west to east. The soil is much poorer than of Plot I and consists of light black soil, mixed somewhat with *marum*. It contained the following species, those italicised being the most prominent:—

Sporobolus indicus.	<i>Setaria glauca.</i>
<i>Andropogon pumilis.</i>	<i>Tripogon jacquemontii.</i>
Sporobolus diander.	Heylandia latebrosa.
Paspalum Royleanum.	<i>Andropogon contortus.</i>
Andropogon annulatus.	Hydrocotyle asiatica.
Euphorbia hypericifolia.	<i>Iseilema anthophoroides.</i>
Biophytum sensitivum.	<i>Lophopogon tridentatus.</i>
Cocculus villosus.	<i>Pulicaria wightiana.</i>
Cassia tora.	Ischaemum laxum.
Zornia diphylla.	Cassia pumila.

III. Nine-fortieths of an acre of land, with a slight slope east to west. The soil was poor and shallow and in some places the surface was bare trap rock. In no part was the soil more than four inches in depth. It contained the following species, those italicised being the most prominent:—

<i>Lophopogon tridentatus.</i>	Chlorophytum tuberosum.
Iseilema anthophoroides.	Andropogon pumilis.
Ischaemum laxum.	<i>Aristida reducta.</i>
Indigofera cordifolia.	<i>Gracilea Royleana.</i>
Andropogon foveolatus.	Eragrostis bifaria.



<i>Cocculus villosus.</i>	<i>Andropogon monticola.</i>
<i>Manisuris granularis.</i>	<i>Sporobolus diander.</i>
<i>Andropogon contortus.</i>	

The existing vegetation on all these plots was cut in November 1915, and removed, while the land was ploughed (except in Plot III) and the clods broken in December. Reploughing took place in January 1916 and harrowing followed. In Plot III, the land was only scraped, as there was little soil to be turned. In all cases the soil was then left exposed to the sun and aeration through the hot weather, and then was harrowed and prepared for sowing after the advent of the monsoon in June (1916). Plot I was then manured with five hundred pounds of basic slag per acre, and beyond this half of the plot received ten tons (twenty tons per acre) and the other half five tons (ten tons per acre) of farmyard manure. The other plot had no manure.

All the plots were carefully fenced with green *babul* (*Acacia arabica*) branches. This fencing is essential to the success of any improvement. This will be seen later, but we can fully endorse the American conclusions\* that such fencing forms perhaps the most vital factor in the improvement of grazing lands.

Having so prepared the land, the question of the most suitable mixtures of grasses to be sown had to be considered. To decide this, the only evidence from Western India that we have, is contained in a bulletin† by Burns, Bhide, Hanmante and the author published in 1916 from the results obtained at Tegur (Dharwar District) on poor laterite soil. The following mixtures were classed as good :—

1. Sudan grass	} Yield of green fodder in first year.	} 6,400 lbs. per acre.
<i>Alysicarpus rugosus.</i>		
2. <i>Andropogon caricosus.</i>	} Yield of green fodder in first year.	} 18,000 lb. per acre.
<i>Indigofera glandulosa</i>		

\* See United States Department of Agriculture Bulletin 63 (Grazing on the Public Lands, page 15).

† Bombay Department of Agriculture Bulletin 78 (1916).

3. <i>Andropogon</i>	} Yield of green	} 8,800 lbs.	
<i>pertusus.</i>			fodder in first
<i>Alysicarpus rugosus.</i>			

In the present case, however, it was decided to give up these very simple mixtures, and utilise a combination of seed of the best fodder plants normally found in Deccan grass lands. The mixtures used contained the following species:—

*Annual Grasses—*

<i>Andropogon purpureo-sericeus.</i>	<i>Thelepogon elegans.</i>
<i>Anthistiriaciliata.</i>	<i>Apluda varia.</i>
<i>Ischaemum sulcatum.</i>	<i>Iseilema anthophoroides.</i>
<i>Paspalum sanguinale.</i>	<i>Eragrostis pilosa.</i>
<i>Polytoca barbata.</i>	<i>Coix Lachryma Jobi.</i>
<i>Andropogon pumilis.</i>	

*Perennial Grasses —*

<i>Andropogon monticola.</i>	<i>Chloris barbata.</i>
<i>Cenchrus biflorus.</i>	<i>Pennisetum cenchroides.</i>
<i>Andropogon caricosus.</i>	<i>Andropogon-pertusus.</i>
Sudan grass (foreign).	<i>Tricholeana rosea</i> (foreign).
<i>Ischaemum rugosum.</i>	<i>Iseilema wightii.</i>

*Leguminous Plants—*

<i>Indigofera glandulosa.</i>	<i>Indigofera trifoliata.</i>
<i>Psoralea corylifolia.</i>	<i>Heylandia latebrosa.</i>
<i>Alysicarpus rugosus.</i>	<i>Tephrosia purpurea.</i>
<i>Sesbania aculeata.</i>	<i>Indigofera linifolia.</i>

All these plants are local and occur in Deccan grass lands except Sudan grass and *Tricholgena rosea* which were imported. It will be seen that they made little or on

difference to the results. In Plot II, six pounds of maize seeds were added to the mixture on half the plot. One hundred pounds of the above mixture were sown on Plot I (one acre) sixty pounds on Plot II (half an acre) and twenty-five pounds on Plot III (nine-fortieths of an acre). This was at the rate of one hundred pounds per acre in Plot I, one hundred and twenty pounds per acre in Plot II and one hundred and ten pounds per acre in Plot III.

The purpose of sowing a mixture of the seeds of such a large number of plants was to provide grasses suitable for each depth of soil to obtain an early crop of green grass (in three months) which would tend to suppress weeds, while providing abundant grasses of slower growth and perennial character to make a permanent pasture, to give grasses suitable for both grazing and cutting, and to obtain a mixture which will contain plants suited to the different seasons in the very variable climate of the Deccan.

The selection was to a certain extent determined by previous observations of the prevalence of some of the species in the Deccan. On the *kurans* at Moshi, twelve miles from Poona, for example, it was noticed that *Andropogon contortus* and *Aristida funiculata* (which are very poor grasses) were chiefly prevalent on soil varying from two to four inches in depth, and that *Anthistiria ciliata* and *Iseilema anthophoroides* (which are much better grasses) slightly mixed here and there with *Andropogon caricosus* (which is a really good grass) replaced the former in the same *kuran* in soil varying from six to eight inches in depth. On soil of more than this latter depth, *Andropogon caricosus*, slightly mixed with *Iseilema anthophoroides* was predominant.

Again at Kirkee, five miles from Poona, it was observed that *Lophopogon tridentatus* and *Aristida funiculata* were the dominant species on soil from two to four inches deep, while *Andropogon contortus* was prevalent on soils a little deeper, from four to six inches in depth. At this place *Ischaemum laxum*, slightly mixed with *Andropogon pertusus* was predominant on land more than six inches deep. In both these centres when the soil becomes more than six to eight inches deep it usually ceases to be grass land and is cropped with *jowar* (*Andropogon sorghum*) or at least with *bajri* (*Pennisetum typhoideum*).



Govt. Photozinc. Office,  
Poona, 1923.

**Plot No. II.—Government House Compound.  
Medium soil. First crop of annual grasses.  
September, 1916.**

The history of the plots sown as described above may now be indicated:

*Observations in 1916.*—The year 1916 was a fairly normal one, though there was an unexpected drought for a month in July, and the seedlings in the plots had to be saved by watering twice from the canal during this period. After this the year was uniformly favourable, the total rainfall being twenty-six inches.

Maize which was put in as a nurse crop, did not thrive anywhere; of the mixture of seeds in Plots I and II, the following first appeared and grew quickly (*see* plate "First crop of annual grasses, 1916") the italicised species being dominant in the first stages:—

<i>Andropogon purpureo-sericeus.</i>	<i>Thelepogon elegans.</i>
<i>Anthistiria ciliata.</i>	<i>Ischaemum sulcatum.</i>
<i>Iseilema anthophoroides.</i>	<i>Andropogon pumilis.</i>
<i>Apluda varia.</i>	<i>Paspalum sanguinale.</i>
<i>Eragrostis pilosa.</i>	<i>Indigofera glandulosa.</i>
<i>Indigofera trifoliata.</i>	<i>Indigofera linifolia.</i>
<i>Setaria glauca.</i>	

Of the original vegetation, the following species were found scattered through these plots:—

<i>Leucas stricta.</i>	<i>Anotis montholoni.</i>
<i>Pulicaria wightiana.</i>	<i>Lophopogon tridentatus.</i>
<i>Tripogon jacquemontii.</i>	<i>Andropogon contortus.</i>

The whole of the two plots was cut in the last week of September when many of the annual grasses were in flower and the grass was eaten readily by cattle. The mixed grasses gave the following figures for analysis in the green condition:—

	Per cent.
Moisture	67·9
Ether extract	... 0·5
Albuminoids	... 1·8
Nitrogen free extract	... 13·5
Woody fibre	... 12·7
Ash	... 3·5
	<hr/> 100·0 <hr/>
Nitrogen	... 0·28
Sand and Silica	... 0·3

The yield over the two plots was 16,000 pounds of green grass per acre. A month later a new growth had been made consisting chiefly of *Andropogon purpureo-sericeus*, *Thelepogon elegans*, *Anthistiria ciliata*, *Apluda varia* and *Ischaemum sulcatum*, while the following perennial grasses began to appear scattered in the plots, *Andropogon caricosus*, *Andropogon pertusus*, *Andropogon monticola* and *Chloris barbata*. The mixed grasses were allowed to grow and seed themselves. The dried remains were cut in February 1917 and fed to cattle. Though coarse and woody, the produce was eaten fairly readily by cattle, and it gave a yield of 1,000 pounds of dry material per acre. The analysis of this material is shown below. The plots then remained dry until June 1917:—

	Per cent.
Moisture	... 7·6
Ether extract	... 1·2
Albuminoids	... 2·3
Nitrogen-free extract	... 39·2
Woody fibre	... 39·3
Ash	... 10·4
	-----
	100·0
	-----
Nitrogen	... 0·37
Sand and Silica	... 0·4

As a result of the first year's observations on the plot it was evident that some of the annual grasses and leguminous plants grew very rapidly, and got ahead of all the perennial grasses. They formed an efficient nurse crop to the perennial grasses which appeared later and grew much more slowly. The original vegetation, particularly *Andropogon contortus* and *Lophopogon tridentatus*, which were particularly prevalent previously, were largely suppressed, probably on account of the rapid growth of the annual grasses and leguminous plants which were introduced.

On Plot III, comprising the poorest and shallowest land, the seedlings of the annual grasses came up satisfactorily but were very much affected by the long drought in July, especially as this land could not be irrigated. Afterwards

good progress was made and the following plants were prominent. The dominant species were, however, *Andropogon purpureo-sericeus* and *Thelepogon elegans*, while *Anthistiria ciliata* and *Indigofera glandulosa* stood next:—

<i>Andropogon purpureo-sericeus.</i>	<i>Thelepogon elegans.</i>
<i>Iseilema anthophoroides.</i>	<i>Andropogon pumilis.</i>
<i>Paspalum sanguinale.</i>	<i>Anthistiria ciliata.</i>
<i>Indigofera glandulosa.</i>	<i>Indigofera trifoliata.</i>
<i>Tephrosea purpurea.</i>	

Of the original vegetation, *Lophopogon tridentatus*, *Tri-pogon jacquemontii*, *Andropogon contortus*, *Cocculus villosus*, *Gracilea Royleana* and *Chlorophytum tuberosum* were found scattered.

The grass was cut in September and fed to cattle when the yield was 5,000 pounds of green grass per acre. After a month *Andropogon purpureo-sericeus* and *Thelepogon elegans* produced a second growth. *Andropogon caricosus*, *Andropogon pertusus* and *Andropogon monticola*, all perennial species, were seen scattered in the area. These, and the second growth of the previously harvested grasses, were allowed to grow and seed themselves for the ensuing year. They were cut in February 1917 after the fall of all the seeds. The yield at this time was 940 lbs. dry grass per acre.

It was quite striking on this plot to see that *Andropogon contortus*, *Lophopogon tridentatus*, *Aristida redacta* and *Gracilea Royleana*, that were dominant previously, were reduced to a great extent the very first year, even on poor land.

*Observations in 1917.*—In the year 1917, although the total rainfall was normal (twenty-six inches) it was unsatisfactory for the first three months of the growing season; June, July and August, and hence the progress of the grasses was hindered. With the first rain in June, however, thirty-six pounds per acre of the following grasses were sown, without any cultivation, on Plots I and II:—*Andropogon caricosus*, *Andropogon monticola*, Sudan grass and *Thichol-aena rosea*.

The perennial grasses already there, however, put forth new shoots first and then seedlings from the seeds which have fallen in the previous year, and been sown as above, appeared. Later on, the rains were regular and sufficient and a

fair crop was produced chiefly consisting of the following grasses and leguminous plants:—

<i>Andropogon purpureo-sericeus.</i>	<i>Thelepogon elegans.</i>
<i>Ischaemum sulcatum.</i>	<i>Ischaemum laxum.</i>
<i>Iseilema anthophoroides.</i>	<i>Andropogon pumilis.</i>
<i>Andropogon caricosus.</i>	<i>Andropogon monticola.</i>
<i>Andropogon pertusus.</i>	<i>Indigofera glandulosa.</i>
<i>Indigofera trifoliata.</i>	<i>Indigofera linifolia.</i>
<i>Tephrosea purpurea.</i>	

Of the original vegetation, *Andropogon contortus*, *Setaria glauca*, *Leucas stricta* and *Fulicaria wightiana* were found scattered in the plot.

At this stage what now is seen to have been certainly a mistake was made in allowing the land on these plots to be grazed by cattle from the middle of October to the end of November. The perennial grasses were just becoming established and as a result of the early grazing they were trampled and damaged. The soil became drier and hard. On the other hand a certain amount of dung and urine were added to the land. But the general result was very injurious at the stage which had been reached in the development of the plots and no further growth could be seen until the beginning of the following rains.

In Plot III in 1917, thirty-one pounds of seeds per acre of a mixture of *Andropogon caricosus* and *Chloris barbata* were sown at the beginning of the rains and seedlings appeared well. The perennial grasses of the previous year (*Andropogon caricosus*, *Andropogon pertusus* and *Andropogon monticola*) also put forth new shoots, but the following drought on this shallow soil led to the death of many of the new seedlings, while the perennial grasses made a very poor growth. Better growth, however, took place after August when good rains occurred. This plot also suffered from the mistaken and premature grazing in October and November of 1917. As a result the perennial grasses were greatly damaged, and no further growth was seen till the beginning of the rains of 1918. Of the original grasses on this plot, *Lophopogon tridentatus*, *Aristida redacta*, *Gracilea Royleana*, and *Andropogon contortus* were still found, but were far less prominent than before the preparation and re-seeding.

*Observations in 1918.*—The year 1918 was one of very short rainfall. Heavy showers (see Appendix) took place at



the end of May and then little else to the end of the season. The total rainfall was only nine inches, as against a normal of twenty-five to thirty inches. The year was hence a very critical one for these plots, particularly as, owing to the drought, it was very difficult to keep cattle off the plots.

The following observations were, however, made on Plots I and II:—

(1) The original vegetation had almost disappeared from the plots except for scattered plants of *Leucas stricta*, *Pulicaria wightiana* and *Lagasca mollis*. *Andropogon contortus* was only seen along the fence or under bushes where cultivation could not have reached.

(2) Of the annual grasses sown at the beginning of the experiment *Anthistiria ciliata* and *Apluda varia* were still present, but only scattered. *Andropogon pumilis*, *Iseilema anthophoroides* and *Ischaemum laxum* were predominant on the shallower soils. *Andropogon purpureo-sericeus* and *Thelepogon elegans* which were dominant for the first two years and were found to be very useful in checking and stifling the original vegetation, disappeared from these plots.

(3) Of the perennial grasses introduced, the following survived the dry conditions of the year and became dominant on the better soils:—*Andropogon monticola*, *Andropogon caricosus* and *Andropogon pertusus*.

(4) Of the leguminous plants used, *Indigofera glandulosa* and *Indigofera trifoliata*, very prominent in the beginning, disappeared from the plots. *Heylandia latebrosa*, *Indigofera linifolia* and *Alysicarpus rugosus* were found but scattered. *Tephrosia purpurea* was common on the shallower soils.

In general it may be said that, in this very dry year, the perennial grasses, though the growth was only fair, have now established themselves and were prominent in the plots that the annual grasses and leguminous plants seeded in 1916 almost disappeared from the plots; and that the original vegetation was almost suppressed.

The grass was harvested in November and the yield was about 1,000 lbs. dry grass per acre, on both the plots, although the year was a critical one. From November to January 1919, the plots looked fairly green, but afterwards they were dry till the end of the hot weather.

In Plot III, where in a dry season like 1918 the conditions were much more severe than in Plots I and II, the

grasses only made very unsatisfactory progress. The original vegetation of *Andropogon contortus*, *Lophopogon tridentatus* and *Gracilea Royleana* did not proportionately increase, and the good grasses, *Andropogon caricosus*, *Andropogon pertusus* and *Andropogon monticola*, though they grew poorly, survived the very dry conditions of this very dry year.

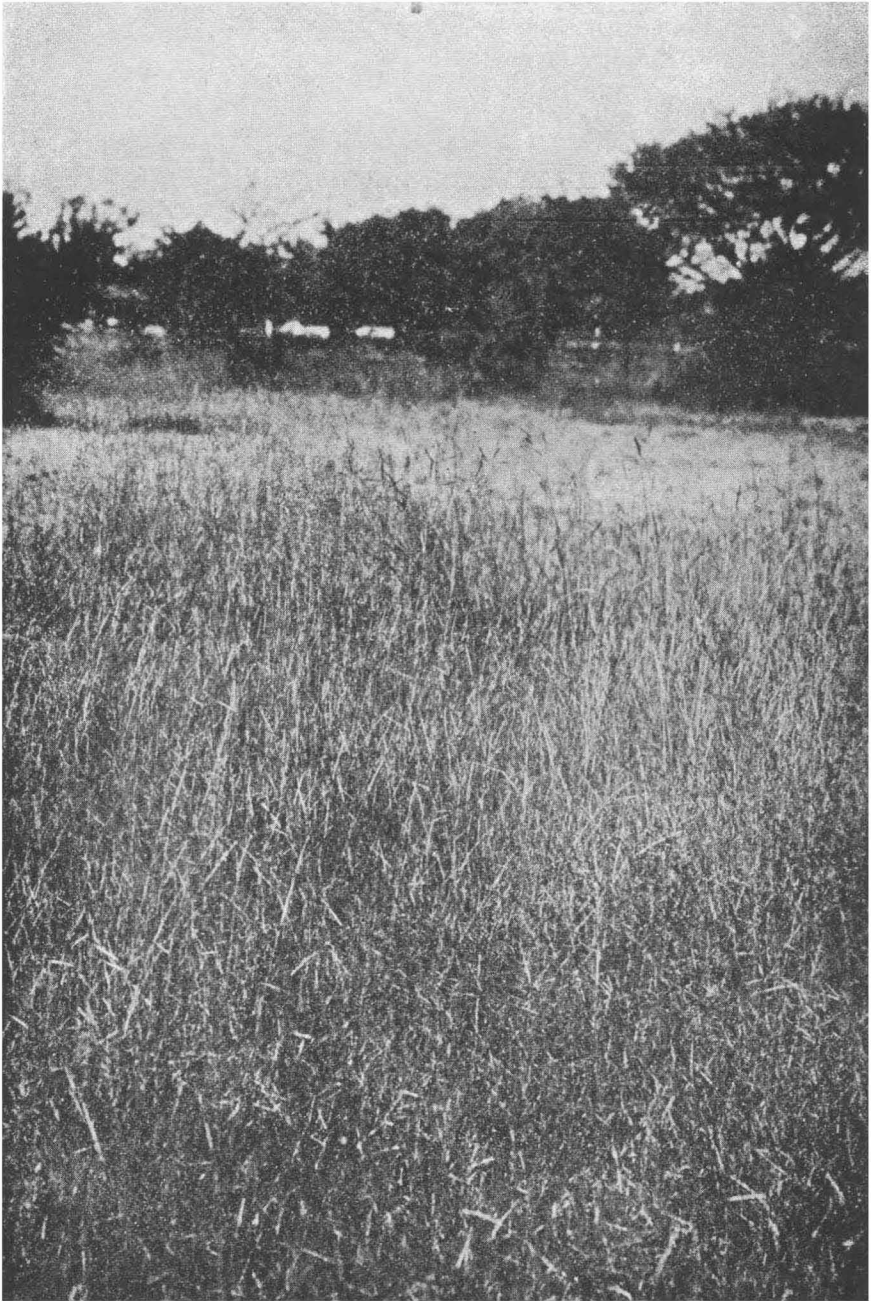
*Observations in 1919.*—This season was favourable from the beginning. In Plots I and II, the perennial grasses which had already established themselves previously, got a complete hold on the area this year, and increased greatly in size and number, producing a large crop of green grass (see plate "Good Perennial grasses completely established, 1919").

Of the annual grasses, *Ischaemum sulcatum* was dominant on good soil. *Andropogon pumilis* and *Iselema anthoporooides* that were prevalent on poor soil in the previous year, decreased to a great extent, and there was an increase to a great extent of *Ischaemum laxum* in their stead. *Anthistiria ciliata* and *Apluda varia* though mixed here and there were still far less common in the plots. Of the leguminous plants, only *Indigofera linifolia* was found to a marked extent on good soils and *Tephrossea purpurea* on poor soils.

Thus by the end of the growing season both the plots had nearly all the perennial grasses completely established in the ground. The operation of establishing the exhausted *kurans* with better grasses thus took four complete years. This period would certainly have been reduced, had the plots not been grazed in 1917, and had the year 1918 not been such a critical one.

The grass was cut late in December and stacked in the experimental plots. The dairy cattle were fed with this dry grass and it was reported that the grass was eaten with great relish. On analysis the grass thus cut gave the following figures :—

	Per cent.
Moisture	... 6·7
Ether extract	... 0·8
Albuminoids	... 2·2
Nitrogen-free extract	... 46·5
Woody fibre	... 32·1
Ash	... 11·6
	<hr/> 100·0
Nitrogen	... 0·35
Sand and Silica	... 0·35



Plot No. II.—Government House Compound.  
Medium soil. Good Perennial grasses completely established.  
October, 1919.

The yield of dry grass amounted to 5,000 pounds per acre of good grass, while similar soil adjoining but not treated only gave 3,000 pounds per acre, chiefly of *Andropogon contortus*.

Turning now to the conditions on Plot III with its very shallow soil which had suffered so much in the drought of 1918, it was obviously necessary to resow the area. Forty pounds per acre of a mixture of seeds of *Andropogon caricosus*, *Ischaemum sulcatum* and *Ischaemum laxum* were sown at the beginning of the rains. The season being favourable the seedlings came up at once, and grew well. The old perennial grasses, namely *Andropogon caricosus*, *Andropogon pertusus* and *Andropogon monticola* also made good progress, and began to look prominent in the plot. The grass was harvested in November and the yield was 6,000 pounds green grass per acre. The stuff was fed to the garden cattle and it was much relished by them.

This year the yield obtained from the plot was therefore not only more when compared with that of 1916 (5,000 pounds) but consisted of better species (*Ischaemum sulcatum* and *Ischaemum laxum*, *Andropogon pumilis*, *Iscilema anthophoroides*, *Andropogon monticola*, *Andropogon pertusus* and *Andropogon caricosus*). The stumps of the perennial species were visible throughout the plot.

*Observations in 1920.*—The season made an excellent start, but it was not satisfactory for long. After a fortnight, there appeared a sudden break, which continued for three weeks, when there were regular showers for about three weeks. There was again a longer break for about a month, which was followed by heavy rain. Although there was thus a rainfall of eighteen inches from June to the end of September, still it was unsatisfactory to the growth of annual grasses, on account of its irregular and uneven distribution.

In Plots I and II, the seedlings from the self-sown seeds of the last year's crop appeared well and made a very good and uniform start owing to the favourable beginning of the season. But when they were subjected to a sudden break in the rains they ceased to grow and looked pale everywhere. The timely rains, however, changed the conditions and stimulated fresh vigour. Unfortunately, before they completely recovered from the shock, they had to face again a fresh and longer drought, which completely killed out most of them. The subsequent showers saved the situation and gave a new life, as it were, to those that survived.

It was quite surprising to see that along with the established perennial grasses, the species that survived were *Ischaemum sulcatum* and *Ischaemum laxum*. These two species with their stunted height, tender stalk and quick growth, were dominant, in the two plots, *Ischaemum sulcatum* being especially prominent on the better soil and *Ischaemum laxum* on the poorer soil.

The established perennial species, that is to say, *Andropogon monticola*, *Andropogon pertusus* and *Andropogon caricosus* put forth fresh shoots at the commencement of the early showers and began to grow well. They did not seem to have been affected by the sudden break that followed. The subsequent rains stimulated them to produce a still better growth. Even the second break which was a longer one, did not affect these species, particularly the first two (*Andropogon monticola* and *Andropogon pertusus*). All these species made an excellent growth and were in flower in September. The plots were harvested in the beginning of October and the yields were 13,640 and 10,000 pounds green grass per acre, respectively, from Plots I and II.

On the whole considering the unsatisfactory conditions of the season for the annual growing grasses, the yield per acre is certainly more than one might expect. It may be emphasised here that but for the suitable mixtures of grasses of different habits of growth, such as early and late, such a heavy outturn would not have been possible.

This year's (1920) experience in fact proves the value of mixture of grasses of different habits of growth, and also proves that the drought resisting character of those perennial species which had been completely established in the two plots.

The observations of the five years can thus be summarised—

(1) The introduced annual grasses and leguminous plants grew first and produced a heavy yield.

(2) They gradually disappeared from the plots, as the introduced perennial grasses became established.

(3) *Andropogon contortus*, an inferior but a prominent grass in the plots before the experiments, was gradually suppressed partly by the cultivation given and partly by the quick growing annual grasses and leguminous plants that were introduced.



Govt. Photozinc. Office,  
Poona, 1923.

**Plot No. III.—Government House Compound.**  
**Very poor land. *Andropogon Monticola* prominent.**  
**October, 1920.**

(4) The introduced perennial grasses after their complete establishment in the ground gave a good yield, both quality and quantity, even under adverse conditions.

(5) *Ischaemum sulcatum*, an annual grass, quick growing and also drought resisting, was found a suitable mixture, with perennial grasses, in farming permanent grass land.

(6) Grazing before the introduced perennial grasses are completely established was found very harmful to establishing grasses.

The results obtained in Plot III were not widely different in spite of it being such shallower land. In the fifth year (1920) though the rains were so irregular, the perennial species, particularly *Andropogon monticola*, now had made a good stand in the whole area (see plate "Andropogon monticola prominent, 1920"). *Ischaemum laxum* was prominent in the early part of the season, and made good early growth, while *Andropogon contortus* and *Lophopogon tridentatus* were a less important part of the herbage than was the case in previous years. The most striking result in this case is the way in which *Andropogon contortus* has been gradually eliminated and good perennial grasses established on such poor shallow land within five years.

These experiments have incidentally given some very interesting results as to the adaptability of some of the grasses and leguminous plants to various depths of soil, and the results noted in this direction may now be described. Plot II showed this specially, the dominant species on the soil of different depths being quite different. To study this, the area under grass was divided into sub-plots, according to the depth of the soil and detailed observations of these sub-plots were made, in November 1918. These observations are given below:

*Description of the Sub-plots—Sub-plot I.*—The soil is *murum*, having many pebbles. It is brown in colour and is, on an average, six inches deep.

*Sub-plot II.*—The soil is slightly reddish, but changing to light black, as the land slopes. It is on an average 8.6 inches deep.

*Sub-plot III.*—The soil is changing from light to medium black, about ten inches deep, and slightly sticky.

*Sub-plot IV.*—The soil is black and changing to light black, as the land slopes.—It is about thirteen inches deep and is sticky.

*Sub-plot V.*—The soil is changing from light black to brown *murum*, mixed with lime nodules, and is about 6·5 inches deep.

The following table shows the kinds of grasses to the proportion in which they were found in the sub-plot. The proportion was determined by eye observations and was corroborated by observations made by several observers:—

Variety.	Sub-plots.				
	1	2	3	4	5
	per cent.	per cent.	per cent.	per cent.	per cent.
<i>Ischaemum laxum</i> ...	30	15	10	...	35
<i>Andropogon pumilies</i> } <i>Iseilema anthophoroides</i> }	45	30	10	...	30
<i>Andropogon monticola</i> ...	10	20	25	25	10
<i>Andropogon pertusus</i> ...	5	15	25	35	10
<i>Andropogon caricosus</i> ...	5	15	20	30	10
<i>Ischaemum sulcatum</i> ...	...	...	5	8	...
<i>Miscellaneous</i> ...	5	5	5	5	5

The miscellaneous group includes *Andropogon contortus*, *Anthistiria ciliata*, and *Tephrosea purpurea* in sub-plots I, II and V and *Iseilema wightii*, *Anthistiria ciliata*, *Iseilema anthophoroides* and *Indigofera linifolia* in sub-plots III and IV.

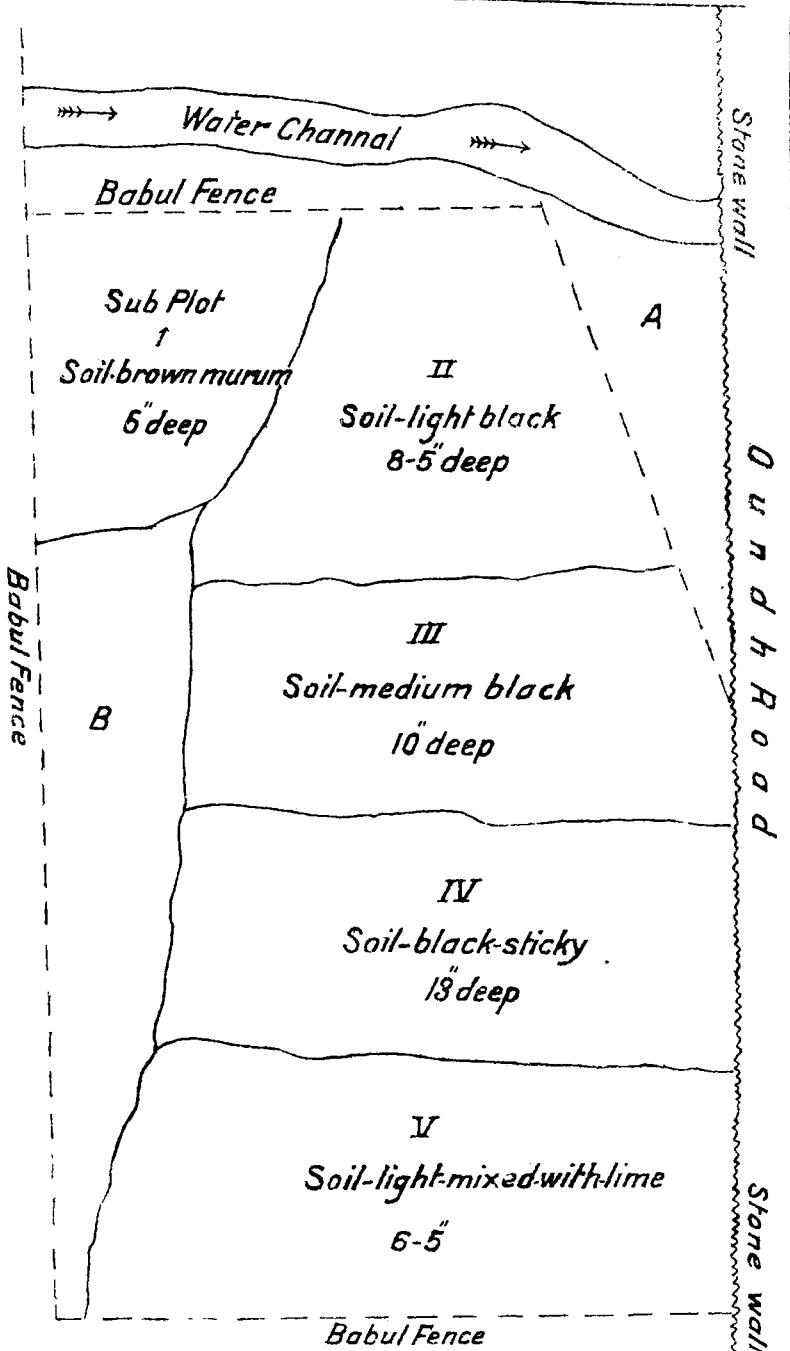
The following notes were made at the same time:—

(1) Plants of *Andropogon pumilies*, *Iseilema anthophoroides*, and *Ischaemum laxum* are dominant and short lived in Plot I where the soil is poor, and decrease to a considerable extent in sub-plots II and III where the soils get deeper, and disappear in sub-plot IV where the soil is the deepest and the richest in the whole plot. They again reappeared in quantity in sub-plot V where the soil is poor.

(2) Plants of *Andropogon monticola*, *Andropogon pertusus* and *Andropogon caricosus* are, on the contrary,



R o a d t o G o v t H o u s e



A = area overshadowed by roadside trees

B = " left bare in 1918.

but prevalent with *Ischaemum laxami* in 1919.

rare in sub-plot I and gradually increase in sub-plots II and III and are dominant in sub-plot IV and again decrease in sub-plot V.

It was also observed that these grasses produced more tillers, were more succulent and lived longer on good soils and *vice versa* on poor soil.

(3) *Anthistiria ciliata* was found coarse and more awned in sub-plots I and V while it was comparatively more succulent and less awned in sub-plots III and IV.

(4) *Andropogon pertusus*, with its peculiar spreading habit of growth, made a very close net work on deepsoil (sub-plot IV), and thus by preserving soil, helped to a great extent to produce a better crop even in a critical year. This grass would appear to serve as a good element of a mixture in the common pasture of the Deccan.

(5) *Andropogon monticola* grows better, especially on shallow soils of black colour, than *Andropogon caricosus* and *Andropogon pertusus*. So it is the pioneer of the perennial grasses to establish on poor soils of the Deccan.

(6) *Ischaemum sulcatum* though drought resistant like *Ischaemum laxum* prefers black soil of medium depth.

A similar set of observations were made in November 1919, the plots having undergone the treatment described on page 15. The table given below shows the kinds of grasses and the proportions in which they are found :—

Variety.	Sub-plots.				
	1	2	3	4	5
	per cent	per cent	per cent.	per cent.	per cent.
<i>Ischaemum laxum</i> ...	40	20	5	0	40
<i>Andropogon pumilis</i> } ...	20	10	0	0	10
<i>Iseilema anthophoroides</i> }					
<i>Andropogon monticola</i> ...	15	25	20	20	15
<i>Andropogon pertusus</i> ...	10	15	30	30	15
<i>Andropogon caricosus</i> ...	10	20	25	25	15
<i>Ischaemum sulcatum</i> ...	0	5	15	20	0
Miscellaneous ...	5	5	5	5	5

The miscellaneous group includes *Andropogon contortus*, *Anthistiria ciliata*, and *Tephrosea purpurea* in sub-plots I, II and V and *Iseilema wightii* and *Andropogon schoenanthus* in sub-plots III and IV.

The following notes were made at the same time:--

(1) Plants of *Ischaemum laxum* have tended to increase considerably in sub-plots I and V over the previous year. They gradually diminish in Plots II and III and entirely disappear in Plot IV.

(2) Plants of *Andropogon pumilis* and *Iseilema anthophoroides* though fairly abundant in sub-plots I, II and V have decreased there since the previous year, and are being replaced by *Ischaemum laxum*. They almost entirely disappear in sub-plots III and IV.

(3) The perennial grasses tend on the whole to increase in sub-plots I, II and III and IV, but seem to be decreasing again in sub-plot V. *Andropogon monticola*, however, decreases in sub-plots III and IV. It seems to thrive, therefore, within a limited range of soil depth.

(4) Plants of *Ischaemum sulcatum* gradually tend to increase in sub-plots II, III and IV and to disappear entirely in Plot V. This shows that it *thrives well in black soil of a fair depth*.

As a further supplement to the experiments so far described, another area, measuring two and a half acres, was taken in Kirkee with soil varying in depth from two to six inches and slightly reddish in colour, in October 1917. At this time *Andropogon contortus* was dominant in the entire area. The grass was cut and removed in November 1917, and the land cultivated in December of that year and January 1918. In July 1918, the area was reseeded with the following mixture of grass seeds:--

<i>Andropogon purpurea-sericeus</i>	...100 pounds
<i>Anthistiria ciliata</i>	... 50 ,,
<i>Thelepogon elegans</i>	... 50 ,,
<i>Iseilema wightii</i>	... 30 ,,
<i>Andropogon caricosus</i>	... 50 ,,
<i>Ischaemum sulcatum</i>	... 20 ,,
<i>Ischaemum laxum</i>	... 20 ,,

One hundred and twenty pounds of the mixture were used per acre.

In 1918 the seedlings came up poorly and were affected by the scanty rains of that abnormal season. Many seedlings, moreover, died and there were so many gaps in the plot that the area was again harrowed and a further quantity of the seed mixture (92 pounds per acre) was sown in August. This time the seedlings came up pretty well, but they too had to struggle on account of the very dry season. Though the growth was poor, *Andropogon purpureo sericeus* and *Thelepogon elegans* were dominant, while *Ischaemum sulcatum*, *Ischaemum laxum*, *Anthistiria ciliata*, *Apluda varia* were found scattered throughout. *Andropogon contortus* was rare in the plot. The crop was harvested in November. The yield was 800 pounds dry grass per acre. A second crop from the above grasses was produced but it was very poor. *Andropogon caricosus* was still not seen in the plot. Thus, notwithstanding the very critical season *Andropogon contortus*, which was the principal grass on this area previously, was reduced to a great extent, while *Andropogon purpureo-sericeus* and *Thelepogon elegans* fared fairly well.

In 1919 sixty-four pounds of seed of the mixture of *Andropogon caricosus* (44 pounds) and *Ischaemum laxum* (20 pounds) were added at the beginning of the rains to the plot. This was at the rate of twenty-six pounds per acre. The season being favourable the seedlings came up well, and the growth was excellent. *Andropogon purpureo-sericeus* was the most prominent grass in the whole area, while *Ischaemum laxum* was not very common. *Andropogon contortus* was even less in amount than in the previous year. The crop was cut late in November after seeding and yielded at the rate of 1,860 pounds of dry grass per acre. The grass was fed to dairy cattle, which maintained their milk yield upon it, at a time when they refused to eat grass consisting of *Andropogon contortus*.

In 1920 in a decidedly unfavourable season, *Andropogon purpureo-sericeus* grew thick and short from the self-sown seed of the previous year, and was prominent in the plot. *Ischaemum laxum* grew well and *Andropogon caricosus* and *Andropogon monticola* were quite visible in various parts of the area; *Andropogon contortus* was only visible in patches where there was no growth of *Andropogon purpureo-sericeus*.

The grass was cut in November and gave a crop of 1,600 pounds of dry grass per acre and the grass was in demand from the surrounding villages. Adjoining untreated areas gave only 500 pounds per acre, and nobody wanted the grass.

## CHAPTER IV.

### *Value of Grasses in Permanent Grass Lands.*

In the successful experiments so far recorded, conducted as they were on typical shallow soils of various value, on the Deccan, the chief grasses which have been established in the plots have been *Andropogon monticola*, *Andropogon pertusus*, *Andropogon caricosus* and *Ischaemum sulcatum*. The first three are perennial and the last annual. We will now discuss the adaptations of each of these grasses, their intrinsic value as fodder, and their performance in growth.

#### *Andropogon Monticola.* Schult.\*

This is very widespread grass in India and grows on dry, sandy and rocky or stony soil. It is found in very coarse grained as well as in fine grained *murum* soil in the Deccan, provided it is highly porous. The soil may vary from being very shallow to about three feet in depth, but beyond this its growth seems limited. It grows at all levels in the Deccan, but is very susceptible to damage from stagnating water. It is one of the best grasses in India for thriving on a dry soil, and resists well the burning of the areas in which it occurs (Hole l. c.)

It is, moreover, a very good fodder. Lisboa states that in Mount Abu it is reckoned a good fodder grass, and that in his time it was much used in Poona (List of Bombay Grasses, 1896, p. 81). Hole (l. c.) speaks of it as probably the most valuable fodder grass in certain areas in North India. He also states that it is severely handicapped by being constantly eaten down level with the ground, which not only seriously

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\*A very detailed account of this grass with its ecology in North India will be found in Hole—Some Indian Forest Grasses and their ecology, Indian Forest Memoirs (Bot. Ser.), Vol. I, Part I.

diminishes the vigour of the plant, but prevents the production of flowers and seed. This is also found to be the case in the Deccan, but if not grazed during its early growth, it gives good outturn during the rains and afterwards stands any amount of grazing during the cold season. In fact, owing to its capacity for resisting drought, this species helps a good deal in keeping cattle alive during famine years, and besides it is one of the species that grow quickly and, if carefully managed, will provide a little food to the hungry cattle in the early part of the season. Although coarse to the touch, cattle eat it with relish when mixed with other grasses.

The following analysis of this grass indicates its general characteristics as a fodder:—

	Dry Grass from Central Provinces.	Green Grass before flowering.	Green Grass in flower.	Green Grass after flowering.
	per cent.	per cent.	per cent.	per cent.
Moisture ...	10.3	78.5	76.8	68.3
Ether extract ...	1.8	1.9	1.8	1.9
Albuminoids ...	2.7	3.1	1.3	1.3
Nitrogen-free extract ...	43.6	9.2	10.7	13.6
Woody fibre ...	33.2	5.1	6.9	12.6
Ash ...	8.4	2.2	2.5	2.3
	100.0	100.0	100.0	100.0
Nitrogen ...	0.43	0.49	0.21	0.21

With careful management the grass is absolutely permanent and though the culms die down annually, we have observed plants to persist for more than twelve years.

*Andropogon pertusus.* ✓

*Andropogon pertusus* has very similar characteristics to that just described, but though even more drought resistant, it will grow on deeper soil than suits *Andropogon monticola* and flourishes better under these conditions. It, however, requires a well-drained soil and will not flourish where water is liable to stand. It has one special value, in that it has a spreading habit of growth, and thus covers the ground like

a carpet in good soil and so shades the land and reduces evaporation (*see* plate "Andropogon pertusus spreading, 1918"). It gives a good crop during the rains and then allows close grazing during the cold season without damage. This is an extremely valuable characteristic in permanent grass land.

The value of this grass has been recognised by many workers. Watt\* says that "it is an excellent grass for grazing and stocking," and Duthie\*\* reiterates the same opinion. Williams† whose experience was almost wholly in North India states that "it gives an abundant crop throughout the year, succulent, sweet and nutritive, readily eaten by horses and cattle...A valuable fodder for milch cattle, makes best hay and excellent silage". In the Central Provinces‡ it is reported to be a vigorous grower giving second class hay, and flowering in September, while in Madras§ it is universally esteemed for its fodder value. Outside India this grass has been equally well spoken of. In Ceylon¶ it is stated that cattle are very fond of it, and that it forms excellent fodder both in the green and the dry condition. In Australia it has also found favour, being considered as one of the best grasses to withstand long drought, while it will bear any amount of feeding||. The only objection, from a feeding point of view, to this grass is its repulsive smell, but when it is mixed with other grasses it is relished well. The following are figures for the analysis of the dry grass from the Central Provinces:—

	Per Cent.
Moisture	... 10·8
Ether extract	... 1·8
Albuminoids	... 4·0
Nitrogen-free extract	... 47·5
Woody fibre	... 28·6
Ash	... 7·5
	100·0
Nitrogen	... 0·64

As to its permanence when properly treated, our observations indicate that a plant will last at least twelve years without failing.

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\* Dictionary of Economic Products of India, Vol. I, p. 249.

\*\* Fodder Grasses of Northern India, p. 38.

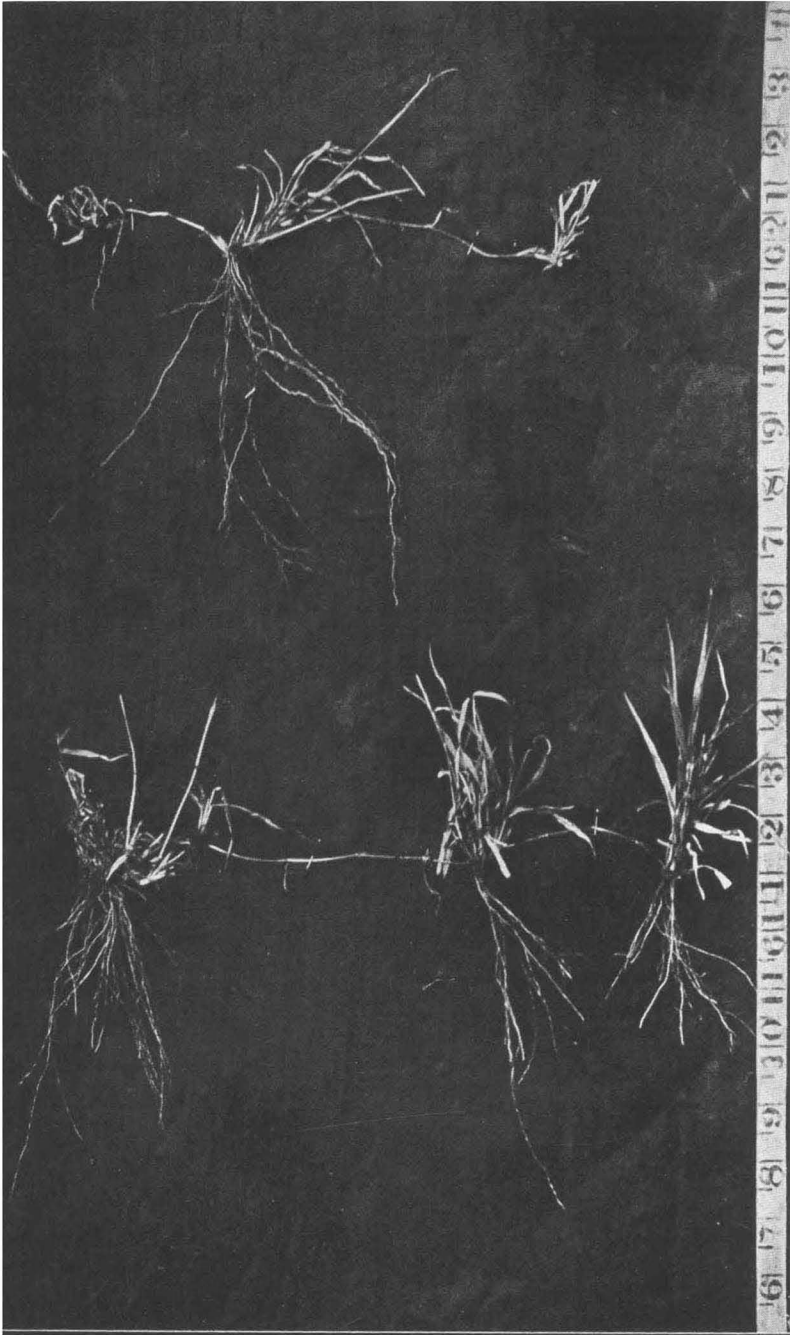
† Farm Manual (1903) p. 50.

‡ Annual Report, Department of Agriculture, Central Provinces and Berar (1910-11, p. 47).

§ Madras Agricultural Department Year Book, 1920.

¶ MacMillan. Tropical Gardening and Planting, p. 588.

|| Agricultural Gazette, New South Wales, Vol. IV, p. 82.



**Andropogon pertusus spreading like Cynodon dactylon.**

**November, 1918. (from Plot No. II.)**



*Andropogon caricosus.*

This species, which is the third, which has proved its value for permanent grass land in the Deccan under dry conditions prefers deeper soil than those previously described. It grows well with moderately deep soil, and in moister situations, but will maintain itself, albeit poorly, and grow slowly on shallow dry soils. Like those previously described, under these last named conditions, it produces less leaves and few and coarse stalks, and ripens earlier than when the conditions are more favourable.

It is universally recognised a good fodder grass where the conditions are suitable. In the Central Provinces\* it has been noted as flowering about three weeks later than *Andropogon annulatus* (*marvel* grass) and giving second class hay,—and in Madras it is recognised as a good fodder grass †. It has been described as an excellent hay grass in the West Indies ‡ where it is replacing other grasses. In the whole of the Bombay Presidency it is definitely recognised as an excellent fodder grass giving a heavy yield, as useful for both cutting and grazing. Under fair conditions of treatment the plants are permanent for at least twelve years.

The following are analyses of this grass, dried in the Central Provinces and in the West Indies :—

	Dry Grass from Central Provinces.	Dry Grass from Anti- gua (West Indies).
	per cent.	per cent.
Moisture	7.8	11.1
Ether extract	1.6	0.7
Albuminoids	3.9	2.1
Nitrogen-free extract	45.8	43.2
Woody fibre	32.1	33.5
Ash	8.8	9.4
	100.0	100.0
Nitrogen	0.62	0.34

\* Department of Agriculture, Central Provinces, Annual Report, 1910-11, page 47.

† Madras Department of Agriculture Year Book, 1920, page .

‡ West India Bulletin, Vol. I, page 413.

*Ischaemum sulcatum.*

Although this is an annual grass it has proved its value in permanent grass land under the conditions we are considering. It grows well in all but the shallowest soil, though it becomes more succulent and tender on the deeper soils. Its special advantage results from the fact that it grows very quickly, seeds very easily, and sows itself. It withstands drought conditions very well and when grown is an excellent grass both for cattle and horses. It is one of the chief grasses of Khandesh. As regards permanence it seeds itself so quickly and easily that unless grazed close in the early stages it will maintain itself from year to year.

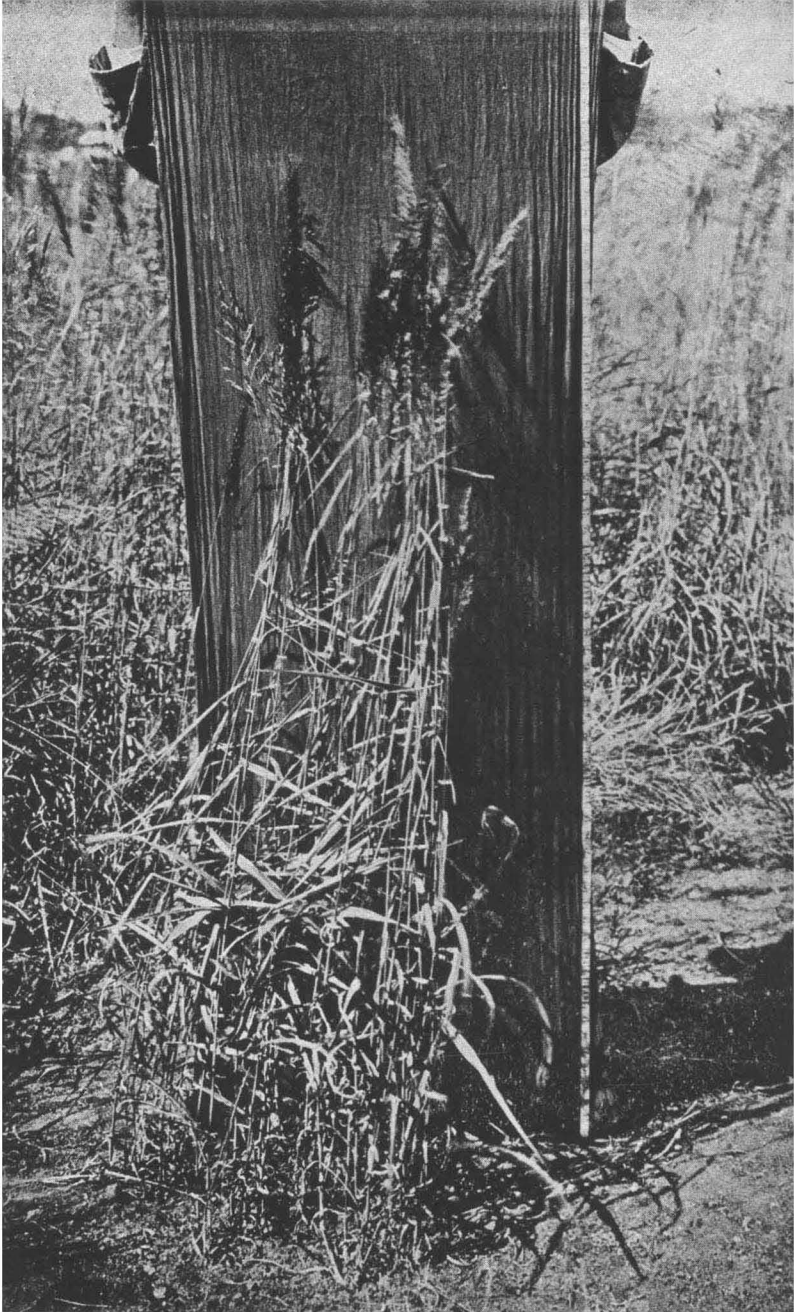
The above grasses appear to be those, which under the conditions of the Deccan near Poona and Kirkee and in the years 1915 to 1920, it is most desirable to encourage in the mixed herbage of permanent grass land. But in the establishment of such grass land there are other annual grasses which have a very great importance and the experiments made have revealed one in particular, *Andropogon purpureo-sericeus*, which has proved to have special importance and an account of which may now be given.

*Andropogon purpureo-sericeus.*

(See plate "A suitable fodder grass for the poor land, 1920".)

Though this species has been described botanically in all the recent floras of Bombay\* none of the authors have looked upon it as of any particular value. A test was, however, made of it along with a number of other grasses and fodder plants in a separate small plot (one-fortieth of an acre) in 1912. It grew well in that year without irrigation and gave an outturn calculated as equivalent to 6,680 pounds of dry grass per acre in December. In the following year the self-sown seeds of the same plot produced a good crop and gave two cuttings, one in September and the other in December, with a total calculated yield, as cut, of 8,920 pounds of produce per acre. The material as cut was at once, on both occasions, fed to cattle and eaten with relish. Similar favourable results were obtained in 1915 when it was grown on a poor laterite soil at Tegur in the Dharwar district.

\* See Cooke, Bombay Flora, Vol. II, page 984, Lesboa, Bombay Grasses and their uses, page 78.



*Andropogon purpureo-sericeus.*

A suitable fodder grass for the poor land of the Deccan.

November, 1920.



Govt. Photozinc. Office,  
Poona, 1923.

**Plot No. IV.—Government House Compound.  
Poor land. *Andropogon purpureo-sericeus* prominent.  
November, 1918.**

Attention was specially drawn to the species, however, when it formed one of the constituents of the mixture of grasses sown at Ganeshkhind (Kirkee) in 1916 (*see* Chap. III) when almost immediately it was noticed as growing specially well and as being dominant, with a thick growth, in all the plots. It seemed, moreover, to have a special faculty of preventing the growth of *Andropogon contortus* which was less prevalent wherever the present grass grew well. The grass was cut in December 1916 and the plots in good and medium soil in which it was dominant gave a return of 16,000 pounds per acre of grass as cut, while that in very shallow and poor soil gave 5,000 pounds per acre. When cut, it was eaten by bullocks with relish. After this a second crop grew and was allowed to seed itself for the succeeding year.

In 1917, in spite of the self-seeding, *Andropogon purpureo-sericeus* was much less common, but the previously prevalent species, *Andropogon contortus*, was now rare and the perennial species designed to form the permanent herbage of the plots were well established. In 1918 *Andropogon purpureo-sericeus* had entirely disappeared. It had, therefore, acted as an efficient nurse crop for the permanent species and had in the meantime given a good yield.

A supplementary experiment on a large plot of two and a half acres from 1917 onward gave similar results even under the very trying conditions of 1918 and succeeding years (*see* pages 22 and 23) (*see* plate "Andropogon purpureo-sericeus prominent, 1918"). In 1919 a test was made to see how far *Andropogon purpureo-sericeus* had been able to suppress *Andropogon contortus*, which was previously dominant. Two plots, ten feet square, were taken and the produce examined, the different species being weighed separately. The results were as follows:—

	I.	II.
	1b.	1b.
<i>Andropogon purpureo-sericeus</i>	... 12	10
<i>Ischaemum sulcatum</i>	... 8	5
<i>Andropogon contortus</i>	... 3	Nil.
<i>Andropogon pumilis</i>	... $\frac{1}{4}$	Nil.

In 1920, on the same plot, seedlings grew abundantly derived from the self-sown seed of the previous year, but suffered when young from two periods of drought, the first lasting three weeks and the second four weeks. In spite of this the species under consideration grew two feet high and was dominant in the area. The effect of the drought on the seedlings was not so serious as was feared. On an area of three feet square 2,480 seedlings were showing signs of sufferings from drought on September 1st, 1920, but of these 2,083 seedlings (or 84 per cent.) survived and flowered in October. *Andropogon contortus* was now entirely absent where *Andropogon purpureo-sericeus* had made a thick growth.

Several further experiences have now been added to those already quoted—

(1) In 1919 a mixture of equal quantities of certain grass seed was sown on a small plot of poor land where *Andropogon contortus* was dominant after proper cultivation. The seeds used were:—

*Annuals.*—*Andropogon purpureo-sericeus*,  
*Apluda varia*, *Ischaemum sulcatum*, *Thelopogon elegans*, *Anthistiria ciliata*.

*Perennials.*—*Andropogon monticola*, *Cenchrus biflorus*, *Chloris barbata*.

In the following October the herbage on a plot, six feet square, had the following composition:—

	Weight. Height.	
	lb.	feet.
<i>Andropogon purpureo-sericeus</i> ...	13	6
<i>Anthistiria ciliata</i> ...	4	5
<i>Apluda varia</i> ...	2	4
<i>Ischaemum sulcatum</i> ...	1	2
<i>Thelopogon elegans</i> ...	1	1

The self-sown seeds gave a good crop of *Andropogon purpureo-sericeus* in 1920 in spite of the drought conditions of that year.

(2) In 1919 a plot of one-tenth of an acre of *kuran* at Athni (Belgaum District) on poor land was taken,

which was overgrown with *Andropogon contortus*. It was cultivated and in July was sown with the following mixture of seeds at the rate of seventy-five pounds per acre: —

	lb.
<i>Andropogon purpureo-sericeus</i> ...	30
<i>Thelepogon elegans</i> ...	20
<i>Apluda varia</i> ...	10
<i>Anthistiria ciliata</i> ...	5
<i>Andropogon caricosus</i> ...	5
<i>Ischaemum sulcatum</i> ...	5

The seedlings germinated satisfactory, but were checked by a drought of a month long in August. They were, however, revived by rain in September. At the beginning of November, it was found that *Andropogon contortus* was rare, but that *Andropogon purpureo-sericeus*, *Apluda varia*, *Anthistiria ciliata* and *Thelepogon elegans* were common and had made fair growth.

(3) In 1920, at Kopergaon (Ahmednagar District) *Andropogon purpureo-sericeus* when sown alone thrived very well, and in a salt affected area its height reached four to five feet. It gave a yield of 3,700 pounds per acre when cut after the ripening of the seed.

In summary, therefore, it may be stated with confidence that:—

(1) *Andropogon purpureo-sericeus*, a wild indigenous fodder grass, is suitable for poor land, grows tall and quickly, and yields by itself up to 5,000 pounds of green grass per acre in the first year.

(2) It suppresses *Andropogon contortus* which is dominant on vast areas of poor land in the Bombay Deccan.

(3) Cattle like the grass as fodder, even when the seed has ripened, and the grass dried better than *Andropogon contortus*.

(4) *Andropogon purpureo-sericeus* resists drought conditions well, even when young.

(5) It acts as a good nurse crop to perennial grasses.

(6) It is a suitable pioneer grass in the artificial re-seeding of grass areas.

## CHAPTER V.

*Andropogon contortus*—and the Necessity for its Suppression.

By far the most common of the grasses found in the grass areas of the Deccan, —formed, as they usually are, of poor soil, and generally much overgrazed—is *Andropogon contortus*, and a consideration of the value of this grass will determine whether the policy in improvement should be to replace it, whether by natural or artificial means, to improve it. It now dominates so much of the area, however, it may at once be said, largely because it is not readily eaten by cattle except when very young, and because its seeds are so easily and widely spread both by wind and by animals.

In order to determine its value as fodder, let us first consider the chemical analysis of the grass in several stages of growth. These are given in the following table : —

	Dry Grass, Ganesh- khind.	Green Grass (before flowering).	Green Grass in flower.	Green Grass after flowering.	Dry Grass, Central Provinces.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	6.0	66.2	62.0	60.3	6.9
Ether extract	1.1	1.7	1.6	1.8	1.2
Albuminoids	2.2	2.4	2.4	1.7	2.1
Nitrogen-free extract	44.5	22.7	22.2	20.4	50.2
Woody fibre	39.1	4.0	5.7	9.1	32.2
Ash	7.1	3.0	6.1	6.7	7.4
	100.0	100.0	100.0	100.0	100.0
Nitrogen	0.24	0.38	0.38	0.27	0.32

These figures simply indicate a grass which seem to be quite nutritious when young, but one which quickly deteriorates after flowering. It becomes, moreover, very hard and woody when dry after seeding, the condition in which it is usually harvested.

When, however, its palatability to cattle is considered, it takes a much lower place than its chemical analysis would indicate. It has usually been considered a useful and



nutritious grass when very young, that is to say, before the flowers are formed. In Australia it is stated by Lisboa \* to be looked upon as a splendid grass for a cattle run, while in India, at Allahabad it is actually cultivated and is stated to produce succulent and tender stalks and soft leaves while awns only appear later. But in the Bombay Deccan at any rate it seems by no means liked by cattle, even before the flowers and awns appear. At this time, however, it is at least edible and the question has been raised as to why it cannot be cut at this stage or even during the progress of flowering, and made into silage. All experience seems to be that the weight of the grass obtained if cut before or at the time of flowering is very small. This is probably not always the case, and not at any rate on good soil, as we have noticed at Bankapur (Dharwar District), this species growing to the height of two feet at the time of flowering in the middle of August. But generally speaking it would appear that under the conditions of the Deccan grass lands it is hardly worth while to cut before flowering.

The real difficulty with this grass, as a fodder, commences with the flowering period when it develops the sharp and barbed awns which give it the name of spear grass. The result is to make the grass almost uneatable, or if eaten, to make it very liable to be injurious to cattle, unless the awns are previously removed. So far as our observations go, we may say that this species is very little eaten, even when young, when almost any other grasses are available. To quote a concrete case where careful observations were made. In September on shallow land near Poona, cattle were admitted to grass land carrying the following grasses :—

*Andropogon pertuses.*      *Iseilema anthopheroides.*

*Andropogon monticola.*      *Ischaemum laxum.*

*Andropogon pumilis.*      *Andropogon contortus.*

On close observation, it was found that *Ischaemum laxum*, *Iseilema anthopheroides* and *Andropogon pumilis* were eaten first and then the cattle stopped eating and looked elsewhere, but they did not touch the remaining grasses, namely *Andropogon monticola*, *Andropogon pertusus* and *Andropogon contortus*. When nothing but these three were

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\* Bombay Grasses and their uses, page 84, Williams—Farm Manual.

found by the cattle there, they began to eat first *Andropogon monticola*, and then *Andropogon pertusus*, while *Andropogon contortus* remained untouched and the cattle left the place.

Similar observations have been made on other sites, and the same order of preference was found when bundles of the various grasses were placed before the cattle for them to select.

An attempt has been made to get rid of the difficulty of the awns by the use of a comb, invented by M. L. Kulkarni, by which the awns are removed from the grass before cutting it for hay. \* But this can only be used after flowering and when the plants are nearly mature and by this time the fodder already very coarse, is rejected by the cattle if anything else is obtainable, and is said to cause the animals eating it to lose condition.†

Taking all these observations together, it would seem that in the universally occurring spear grass we have one of the worst of fodder grasses, and that the problem of grass lands in the Deccan is the problem not of its improvement, but of its suppression and its replacement by better grasses. This is on the whole the opinion held in other parts of India, except in the North. How this can best be done is one of the questions which still demand complete solution, but one method seems to be that described in the preceding chapters of the present paper, namely the ploughing up and cultivation of the area, fencing, and then reseeding with a mixture of grasses of which *Andropogon purpureo-sericeus* should be the most prominent among the annual grasses, with an admixture of valuable perennials such as *Andropogon monticola*, *Andropogon pertusus* and *Andropogon caricosus*.

## CHAPTER VI.

### *The Reseeding of Grass Land.*

The main problem in reseeding is to secure seed with a large germination percentage. Two things reduce this. One is that in many of the so-called seeds of grass, the spikelets contain no seed, and the other is that where seed is present, it frequently fails to germinate. For example, careful

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\* Bombay Department of Agriculture Leaflet No. 3 of 1918.

† With animals eating ripe *Andropogon contortus* balls of the spiky awns tend to form in the month, and thus give much irritation to the animals,

counting of the number of seeds in ten spikelets of fifteen species of grasses gave an average of only 6.5 seeds or actual seeds in only sixty-five per cent. of the spikelets. The others were empty husks. If, out of these, some fail to germinate it is no wonder that the average germination of wild grass seed is often under fifty per cent.

The second factor that affects the germination of the seed is the time of the year when it is sown. In order to determine this factor the seeds of the following species were tested after the harvesting (February) and a second time from the same lot in the beginning of the monsoon (June):—

	February Germination. Per cent.	June Germination. Per cent.
1. <i>Andropogon caricosus</i> ...	35	69
2. <i>Andropogon lawsonii</i> ...	21	65
3. <i>Andropogon pumilis</i> ...	0	22
4. <i>Andropogon purpureo-sericeus</i> ...	0	29
5. <i>Andropogon pertusus</i> ...	3	4
6. <i>Chloris barbata</i> ...	30	48
7. <i>Ischaemum sulcatum</i> ...	1	48
8. <i>Pennisetum cenehroides</i> ...	27	31
9. <i>Thelepogon elegans</i> ...	0	6
10. <i>Trachys mucronata</i> ...	1	14
11. <i>Cenchrus biflorus</i> ...	23	49
12. <i>Andropogon monticola</i> ...	0	1
13. <i>Paspalum sanguinale</i> ...	31	63
14. <i>Cenchrus biflorus</i> ...	25	23
15. <i>Pennisetum cenchroides</i> ...	34	36
16. <i>Apluda varia</i> ...	0	25
17. <i>Anthistiria ciliata</i> ...	0	37

The above table shows that seeds germinate more completely if sown at the beginning of the monsoon.

A third factor that affects the germination of the seeds is the depth to which they are sown. The seeds are small, and if planted deeply the young plants never come up through the surface. If planted shallow, seeds sprout provided they receive satisfactory condition of moisture, but the surface layer of the soil dries rapidly on account of wind and sun and the young plants may die before being able to root well and secure moisture from the damp soil.

*Cultivation.*—Sowing the seeds merely on the surface is not enough. Seeds will germinate no doubt, but owing to the hard nature of the soil, the tender roots of the germinating plants may not easily penetrate into the ground and large numbers of them may die. To avoid this disappointment wherever possible, the land may be ploughed and prepared. The Sabul plough was found very effective on the poor land of the Deccan. The bar that is attached to this plough in place of the share easily penetrates into the *murum*, and thus turns a lump of *murum* soil. There is no fear of the bar-breaking like a share.

If the land is too uneven to admit of any ploughing it should be divided into as many divisions as are possible according to the contouring, and small bunds of soils and stones put as boundary lines across the slopes to catch all the soil and water during the monsoon and allow the vegetation to grow. Thereby the condition of the soil will be improved so as to admit of useful operations.

*Reseeding.*—While reseeded, it is always advantageous to broad-cast a mixture of seeds of the annual and perennial and leguminous plants of the locality in the beginning. The proportion of these species depends on the nature of the soil. The richer the condition of the soil, the less of annual grasses and leguminous plants and *vice versa*. Some more seeds of perennial grasses should be added each year according to the progress of the previous year.

The chief points to be considered while selecting the annual and leguminous plants are as below :—

- (1) They must be fairly good foddere.
- (2) They must grow quickly.
- (3) They must yield a heavy outturn.
- (4) They must serve only as nurse crops, that is to say, they should disappear as the perennial grasses become established.

The chief points in selecting a mixture of perennial grasses for a perennial grass area are that the mixture should consist of grasses of different habits of growth, such as creeping and tall, growing early and late ripening, drought resistant and moisture loving, so as to guarantee some growth and admit grazing even under adverse conditions. Single grasses, unless required for seed purposes, or for any particular object, should not be grown in permanent grass

land. Instances are not wanting to prove the failure of single grasses in permanent pastures (*vide* Chapter II).

*Fencing.*—Fencing is the most essential item in improving exhausted *kurans*. It is the open and unrestricted grazing that has turned the grass land to its present miserable condition, so fencing is necessary until the grasses are well established in the ground. Cactus (*Opuntia elatior*) and *Agave wightiana* serve the purpose with the cheapest cost, but they should be pruned and thinned so as not to allow them to encroach upon the grass area. Barbed wire is more effective, but it is beyond the means of cultivators at least at present. If undertaken with the co-operation of several cultivators it may be very much cheapened.

*Recommendation of Species for different Purposes—(1) Annual and Perennial Character.*—This factor is very important. Firstly it is the perennial grass in any *kuran* that provides at least a little food to the cattle either half fed or starving for a long time from March to June. It provides, moreover, either continuous grazing or frequent cuttings or both under normal conditions, and it is the *kuran* of perennial grasses that keeps thousands of animals alive during famine years.

The following are the perennial grasses most important for our purpose in the Deccan, the most valuable of all being those italicised which has been already described above (Chapter IV):—

<i>Andropogon annulatus.</i>	<i>Ischaemum aristatum.</i>
<i>Andropogon caricosus.</i>	<i>Ischaemum laxum.</i>
<i>Andropogon monticola.</i>	<i>Cenchrus biflorous.</i>
<i>Andropogon pertusus.</i>	<i>Pennisetum conchroides.</i>
<i>Andropogon halepensis.</i>	<i>Chloris barbata.</i>
<i>Andropogon lawsonii.</i>	<i>Iseilema laxum.</i>

The following are the annuals which seem to be worth considering in connection with the reseeded of grass land in the Deccan:—

<i>Andropogon pumilis.</i>	<i>Apluda varia.</i>
<i>Andropogon purpureo-sericeus.</i>	<i>Iseilema anthophoroides.</i>
<i>Thelepogon elegans.</i>	<i>Panicum isachne.</i>
<i>Dinebra arabica.</i>	<i>Paspalum sanguinale.</i>
<i>Anthistiria ciliata.</i>	<i>Ischaemum sulcatum.</i>
<i>Trachys mucronata.</i>	<i>Elensine aegyptiaca.</i>
<i>Politoca barbata.</i>	<i>Coix lachryma-jobi.</i>
<i>Setaria glauca.</i>	



(3) *Drought Resistance*.—This quality is of great importance in an area of such extremely variable rainfall on the Deccan. Highly resistant species are not usually very first class fodders, but, if eatable, they are perhaps of still greater value and more general utility than the latter. The following among the species we have tried have proved themselves specially drought resistant :—

<i>Andropogon monticola.</i>	<i>Ischaemum laxum</i>
<i>Andropogon pertusus.</i>	<i>Ischaemum sulcatum.</i>
<i>Andropogon purpureo-sericeus.</i>	<i>Eleusine aegyptiaca.</i>
<i>Andropogon caricosus.</i>	<i>Iseilema anthophoroides.</i>
<i>Andropogon pumilis.</i>	

(4) *Rapidity of Growth*.—The rainy season in Western India is short and the growing season especially on shallow lands can only be extended by expensive irrigation. Hence a rapidly growing species is especially valuable.

The following species have proved themselves worthy of notice in this respect, ripening in about three months in most cases :—

<i>Iseilema anthophoroides.</i>	<i>Paspalum sanguinale.</i>
<i>Andropogon pumilis.</i>	<i>Cenchrus biflorus.</i>
<i>Andropogon pertusus.</i>	<i>Pannisetum cenchroides.</i>
<i>Andropogon purpureo-sericeus.</i>	<i>Elesine aegyptiaca.</i>
<i>Andropogon monticola.</i>	<i>Trachys mucronata.</i>
<i>Andropogon foveolatus.</i>	<i>Panicum isachne.</i>
<i>Ischaemum sulcatum.</i>	<i>Setaria glauca.</i>
<i>Ischaemum aristatum.</i>	<i>Iseilema laxum.</i>
<i>Ischaemum laxum.</i>	

(5) *Heaviness in Yield*.—Other things being equal, the highest yielding species are the most valuable, and the following have proved themselves valuable in this respect, giving without manure in fair Deccan grass land conditions, above 8,000 pounds per acre on the first crop :—

<i>Andropogon annulatus.</i>	<i>Apluda varia.</i>
<i>Andropogon caricosus.</i>	<i>Anthistiria ciliata.</i>
<i>Andropogon purpureo-sericeus.</i>	<i>Ischaemum sulcatum.</i>
<i>Ischaemum laxum.</i>	

(6) *Value for Hay-Making*.—The necessity of this quality does not need pressing, especially in a country where for six

months in the year there is no green grass at all to obtain. In this respect the following species stand well:—

<i>Andropogon annulatus.</i>	<i>Iseilema wightii.</i>
<i>Andropogon caricosus.</i>	<i>Iseilema laxum.</i>
<i>Ischaemum laxum.</i>	<i>Anthistiria ciliata.</i>
<i>Ischaemum aristatum.</i>	<i>Apluda varia.</i>
<i>Ischaemum sulcatum.</i>	

(7) *Capacity to grow on Poor Soils.*—No good land can be devoted to grasses and there is a vast area of poor land in the Deccan which cannot be utilised for economic crops, so any species that thrive well on this land are really welcomed as they greatly increase the fodder supply to cattle.

The following species have been found specially suited to the poor land of the Deccan:—

<i>Andropogon monticola.</i>	<i>Iseilema anthophoroides.</i>
<i>Andropogon purpureo- sericeus.</i>	<i>Ischaemum laxum.</i>
<i>Andropogon caricosus.</i>	<i>Eleusine aegyptiaca.</i>
<i>Andropogon pertusus.</i>	<i>Paspalum sanguinale.</i>
<i>Andropogon pumilis.</i>	<i>Thelepogon elegans.</i>

(8) *Capacity to stand close Grazing.*—There are perhaps no perennial grasses which will stand very close grazing, especially close grazing by goats and sheep, in their young stages, and such close grazing will almost always largely eliminate such species. The capacity to allow close grazing without injury later in the season varies, however, very much, and the following have proved themselves of special value in this respect:—

<i>Andropogon pertusus.</i>	<i>Andropogon monticola.</i>
<i>Andropogon caricosus.</i>	<i>Andropogon annulatus.</i>
<i>Andropogon foveolatus.</i>	

So far we have dealt only with the grasses which are particularly valuable for special reasons, and which occur in the ordinary herbage of the grass land areas of the Deccan. But to make a permanent piece of productive grass land the presence of leguminous plants is essential. No manure beyond a small amount of the dropping of cattle, sheep and goats is ever likely to be added to such land, and it is hence very largely on the activity of the leguminous plants that we must rely for the maintenance of the fertility. Our study of the leguminous flora, is however, only commencing, but the principal wild plants of this order which occur, give good fodder, and are capable of maintaining themselves under grass



land conditions are as follows. More detailed study of these is now in hand:—

<i>Alysicarpus longifolius.</i>	<i>Sesbania aegyptiaca.</i>
<i>Alysicarpus rugosus.</i>	<i>Desmodium diffusum.</i>
<i>Alysicarpus pubescens.</i>	<i>Sesbania aculeata.</i>
<i>Indigofera tinifolia.</i>	<i>Heylandia latebrosa.</i>
<i>Indigofera cordifolia.</i>	
<i>Tephrosea purpurea.</i>	<i>Cassia pumila.</i>
<i>Zornia diphylla.</i>	<i>Phaseolus triloba.</i>

## CHAPTER VII.

### *The Management of a reseeded Kuran.*

The importance of the management of a reseeded *kuran* cannot be overemphasised. A *kuran* under good and systematic management will probably rarely require reseeding, so management is as much or even more important than re-seeding. It has already been sufficiently shown in this paper how good fodder grasses, if overgrazed, gradually get thin and are at last replaced by hardy and inferior grasses and thus the carrying capacity of a *kuran* is much reduced. We have had the opportunity of visiting a large number of *kurans* in the Deccan and found them mostly in an unsatisfactory condition and consequently giving a low yield per acre.

The prominent grasses of a good *kuran* are generally—

<i>Andropogon annulatus.</i>	<i>Andropogon caricosus.</i>
<i>Andropogon foveolatus.</i>	<i>Andropogon pumilis.</i>
<i>Ischaemum laxum.</i>	<i>Ischaemum sulcatum.</i>
<i>Iseilema wightii.</i>	<i>Ischaemum laxum.</i>
<i>Anthistiria ciliata.</i>	<i>Andropogon pertusus.</i>
<i>Andropogon monticola.</i>	

These are all perennial except *Ischaemum sulcatum* and *Anthistiria ciliata*.

In managing such *kurans* as have been described the following mistakes seem to be made as judged by our present knowledge and in the light of the experiments here recorded:—

(a) The grass is generally cut late in December when the crop has become woody and thus somewhat unpalatable and indigestible to cattle. It is quite possible to take two cuttings, one in October, (the produce being either used for silage or for hay, whichever possible) and the other in February, when most of the seeds have fallen, the produce being used as hay.

There is a practice in the Surat District of allowing cattle to graze during the month of July in the grass lands. From the middle of August or so to October the area is shut from grazing. By this system more succulent grass is produced and there is no fear of the grass being laid down owing to heavy rains later on.

Two cuttings are being successfully taken, we noticed, in some of the States of the Southern Maratha Country. The common excuse for not harvesting the crop earlier is generally the scarcity of labour and unfavourable conditions of the weather. These difficulties can be mitigated by labour saving appliances.

Experiments in the Ganeshkhind Botanical Gardens gave the following results per acre when certain grasses were cut early and late. In 1912 and 1914 the grasses were cut in December and in 1913 they were cut in September and further cuttings also were taken. It will be seen from the table that there is decidedly a larger yield of grass in most cases when it was cut earlier and it was also noticed that the grass produced was eaten with greater relish by cattle :—

Name.	Year.	Yield, Green. lbs.
<i>Andropogon annalatus</i>	1912	8,200
	1913	11,920
	1914	8,400
<i>Andropogon pumilis</i>	1912	2,120
	1913	15,920
	1914	4,160
<i>Andropogon purpureo-sericeus</i>	1912	3,340
	1913	8,920
	1914	8,160
<i>Andropogon lawsonii</i>	1913	12,600
	1914	7,520
<i>Ischaemum sulcatum</i>	1912	6,300
	1913	7,120
	1914	4,160
<i>Iseilema wightii</i>	1912	4,400
	1913	7,720
	1914	6,080
<i>Panicum Isachne</i>	1912	800
	1913	1,230
	1913	560
<i>Chloris virgata</i>	1912	2,860
	1913	5,200
	1914	3,120
<i>Andluda varia</i>	1912	5,780
	1913	1,600
<i>Pennisetum cenchroides</i>	1912	5,080
	1913	6,040

(b) In most of the *kurans* cattle are let loose to wander in the whole area and very little economy is observed in utilising the produce, that is, there is more wastage than actual use.

(c) In some of the *kurans*, although the grass is abundant from March to June for the cattle to graze still it cannot be utilised for want of water and shade during that time. There is a vivid instance at Pimpalgaon Basvant, Nasik District, where in a *kuran* of 800 acres with sufficient grass there is no arrangement for the cattle to drink water during the hot weather and the stuff is merely wasted. Similar instances are found almost over the Deccan area.

(d) In some of the *kurans*, along the Krishna river, actual cultivation is being commenced at the cost of the *kuran*, and the Babul trees, which generally encourage tender growth of grass and prevent erosion of the *kuran* by binding the soil with their roots, are being lavishly cut for agricultural or domestic use by the tenants and no attempt is made to replant them.

These are the chief and the most important drawbacks that we observed in the management of *kurans* in the Deccan.

No hard and fast rule can be laid down for the guidance of the good management of a *kuran* in any tract until the life history and the relative economic importance of the grasses of that particular tract are looked out and systematically studied. With the present knowledge of the few grasses of the Bombay Deccan that have been studied and with experience gained in the last ten years the following scheme seems feasible and may be of use in the better management of *kuran* in the Deccan:

After the replanted *kuran* is well reseeded with better fodder grasses as described in previous chapters the area should be divided into three blocks. Call them A B and C. The first year the following should be the programme:—

*Block A.*—This block is to be grazed from July to October and then to be enclosed. The growth that is produced from November to the end of February should be harvested in March and used as dry grass. By this time the seeds from the second growth would have dropped and be available for self-sowing for the ensuing year.

*Block B.*—The crop that is produced from June to the end of September should be harvested in October and used either for silage or for hay, as the circumstances permit. From November to the end of February it should be open for grazing.

*Block C.*—Two cuttings of the crop should be taken, one in October at the flowering stage and another in March after the seeds fall down. The produce from the first cutting should be used either for silage or for hay and that from the second for hay, and from March to the end of June grazing should be allowed.

The programme for the following year would run thus:—

*Block B.*—This is to be grazed from July to October, the second growth from November to February being cut and used as hay.

*Block C.*—The crop to be harvested in October and used either for silage and for hay. From November to February it should be grazed.

*Block A.*—Two cuttings should be taken, one in October and the other in March. The crop from the first cutting should be used for silage or for hay and that from the second as hay. From March to the end of June it should be grazed.

For the succeeding year, Block C should be treated as A, Block A to be treated as B and Block B as C and so on.

The chief advantages of the scheme are:—

(1) There will be a provision for grazing throughout the year. From September to the end of December bullocks are generally much engaged and very little grazing is necessary at that time. This is an advantage because the surplus grass would be cut and used either for immediate use or for drying to be used later. Similarly from August to the end of November the supply of grass is generally abundant, and will be available for cutting under good management and used as dry grass when necessity arises. There will be very little growth for grazing from March to the end of May as the conditions are quite unfavourable, so more stuff is required for stable feeding at this time. The tract

round Poona is favoured with ante-monsoon showers, sometimes from March onwards and frequently in May, so there is generally some growth produce on account of this moisture and it will be useful for grazing under systematic management. Thus it will partly help to minimise the scarcity of fodder that is keenly felt at that time. The main object of keeping aside a separate section for grazing although there is not sufficient growth, is specially to give exercise and open air to the cattle when they have practically no work.

(2) There will also be a store of either silage or hay or both to supplement grazing whenever needed.

(3) Since every section is successively grazed a good quantity of manure in the form of droppings of the animal is added every year to the soil. It is to be remembered that if this manure does not get back to the soil the land will inevitably and continuously become poor. This is really very essential, since it is beyond recommendation directly to manure grass lands when grain crops such as *jowar*, wheat, and rice are starving for the plant food requirements.

(4) Every section by this scheme gets a certain rest after grazing and this is really essential. Continuous grazing is detrimental to the growth of good fodder grasses, since they get very little opportunity to make proper development and seed. Although the reseeded grasses are perennial and increase by stumps still many of them do require self-seeding to produce a better yield, and it is one of the reasons that the cultivators always prefer cutting the grass late in December rather than early in October.

The following are essential points to be observed in the management of grazing:--

(1) Cattle should never be allowed to move at random in the whole area to be grazed during the season, if they are allowed to be so they often pick up their grazing here and there and thus cause a considerable damage to the vigorous growth of grass by constant trampling over it. So there is no uniform utilisation of the crop produced. The best way to avoid this difficulty is to divide grazing into compartments. The

number of compartments is to be determined by the number of cattle to be grazed and by the intensity of the crop\*. The idea of grazing in compartments is really novelty not only to the cattle, but also to people in this country. This method is, however, practised with success in Nellore (Madras Presidency). The grazing by the compartment system is made more easy by fencing round each compartment and wherever possible by erecting water sheds and placing salt blocks in various places in the compartments to be grazed. These things generally attract cattle and thus prevent them from going from one compartment to the other.

(2) No grazing should be allowed when the soil is wet, otherwise it will get packed and ultimately will turn impervious to moisture, a condition which is detrimental to the growth of suitable fodder plants.

(3) At first protection must be absolute, but meantime the grass that grows up abundantly can be cut and supplied as fodder till the grasses are sufficiently established to admit of grazing.

(4) As soon as the yield decreases and inferior grasses appear in the *kuran* it may be broken for reseeded. Generally the Deccan soil grows a number of wild leguminous plants which under good and systematic management, go to help partly to keep up the fertility of the land longer. In Western Countries a regular method of rotation of crop in grass lands is observed in order to maintain the fertility of the land and to get better crops.

(5) Useful trees such as *Acacia arabica* should be planted in rows. Too much thick growth of such trees reduces the quality of grass. This was clearly observed on the Chharodi farm (Gujarat) where now thick Babul trees are in existence and under them only useless grass is growing. Similar observations have been made near Kirkee. The scheme is really simple and easily manageable if systematically practised by means of co-operation of villagers where large *kurans* are available. It will not only improve the condition of cattle and of agriculture, but will also better the financial status of the villagers. For instance, it may be quoted here that

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\* Voelcker's Report on the Improvement of Indian Agriculture, page 17.

at Pimpalgaon -Basvant, a village in Nasik District, a *kuran* of 800 acres is being managed with success by co-operation of the land holders.. Every year 200 acres are set apart for grazing for the cattle of the land holders of the village and six hundred acres are harvested for hay, which not only suffices for the whole year to the cattle of the village, but every year there is also some surplus quantity which is sold to those having cattle but no lands, and this amount of money is utilised for the public good.

So when it is possible in one case, it must be so in other cases too with at the most some modifications, if necessary, according to the locality.

Before concluding I may express that I am greatly indebted to Dr. William Burns, the Economic Botanist to Government, Bombay, Poona, who gave me every facility and encouragement in my work and under whose kind and sympathetic guidance and supervision the whole work was conducted, and also to Dr. Harold H. Mann, the Director of Agriculture, Bombay, who carefully went over the manuscript and rendered me invaluable service in drafting this Bulletin in its final present form.

## Statement of Ranfa in the year 1916.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1	...	...	...	...	...	...	...	0.24	...	...	...	...
2	...	...	...	...	...	0.42	...	0.02	...	0.08	...	...
3	...	...	...	...	...	...	...	0.02	0.25	...	...	...
4	...	...	...	...	...	...	...	0.22	0.07	...	...	...
5	...	...	...	...	...	0.31	0.04	0.23	2.17	...	...	...
6	...	...	...	...	...	0.22	0.08	0.33	1.50	...	...	...
7	...	...	...	...	...	...	...	0.33	0.40	...	0.30	...
8	...	...	...	...	...	0.45	...	0.10	0.02	...	0.07	...
9	...	...	...	...	...	...	...	...	0.04	...	...	...
10	...	...	...	...	...	...	0.04	...	0.19	...	...	...
11	...	...	...	...	...	...	...	...	2.75	0.21	...	...
12	...	...	...	...	...	...	...	0.10	0.77	...	...	...
13	...	...	...	...	...	...	0.13	0.45	0.12	0.29	...	...
14	...	...	...	...	...	0.01	0.21	0.06	..	...	...	...
15	...	...	...	0.18	...	0.02	...	0.32	...	...	...	...
16	...	...	...	...	0.01	0.02	...	0.23	0.05	...	...	...
17	...	...	...	...	...	0.27	0.06	0.38	...	...	...	...
18	...	...	...	...	...	0.10	...	0.15	0.02	...	...	...
19	...	...	...	...	...	0.25	0.34	...	0.10	0.12	...	...
20	...	...	...	...	0.01	...	...	...	2.10	...	...	...
21	...	...	...	...	...	...	0.22	0.02	0.02	...	...	...
22	...	...	...	...	0.21	0.08	0.15	0.05	...	...	...	...
23	...	...	...	...	0.17	0.07	0.55	0.04	...	2.66	...	...
24	...	...	...	...	...	0.01	0.10	...	...	2.34	...	...
25	...	...	...	...	...	...	0.51	...	...	...	0.36	...
26	...	...	...	...	...	...	0.05	...	...	0.15	0.1	...
27	...	...	...	...	0.27	...	0.60	...	...	0.04	...	...
28	...	...	...	...	0.38	...	0.11	..	...	0.04	...	...
29	...	...	...	...	0.02	...	0.73	0.03	...	0.14	...	...
30	...	...	...	...	...	...	0.17	0.07	...	...	...	...
31	...	...	...	...	0.03	...	0.21	...	...	...	...	...
Total.	...	...	...	0.18	1.13	2.23	3.70	3.39	8.57	7.7	0.74	...

Total during the year ... 26.31



## Statement of Rainfall in the year 1917.

	Jan.	Feb.	March	April.	May.	June.	July.	August.	Sept	Oct	Nov.	Dec.
1	...	...	...	...	...	0.12	0.21	0.05	...	0.22	...	...
2	...	...	...	...	...	0.10	0.05	...	0.36	0.10	...	...
3	...	1.00	...	...	...	...	0.10	0.05	0.04	...	...	...
4	...	0.08	...	...	...	...	0.03	0.01	0.05	...	...	...
5	...	...	...	...	...	0.30	...	...	0.11	0.35	...	...
6	...	...	...	...	...	0.09	0.09	...	0.02	0.46	...	...
7	...	...	...	...	...	0.79	...	...	0.08	...	0.08	...
8	...	...	...	...	...	...	0.02	0.02	0.06	...	...	...
9	...	...	...	...	...	...	...	0.10	0.03	...	...	...
10	...	...	...	...	...	...	...	0.02	0.01	...	...	...
11	...	...	...	...	...	...	...	0.01	0.04	...	...	...
12	...	...	...	...	...	0.62	...	0.02	...	...	...	...
13	...	...	...	...	...	0.20	...	0.09	0.03	1.18	...	...
14	...	...	...	...	...	0.17	...	0.29	0.08	0.31	...	...
15	...	...	...	...	...	0.20	...	0.42	0.16	0.23	...	...
16	...	...	...	...	...	...	0.06	0.01	0.11	0.61	...	...
17	...	...	...	...	...	...	0.04	0.01	0.02	...	...	...
18	...	...	...	...	...	0.12	...	...	...	0.13	...	...
19	...	...	...	...	...	...	...	...	...	0.15	...	...
20	...	...	...	...	...	0.50	...	...	0.03	0.30	0.56	...
21	...	...	...	...	...	0.53	0.18	...	...	0.04	1.40	...
22	...	...	...	...	...	0.55	0.07	0.11	...	0.12	0.78	...
23	...	...	...	...	...	0.05	0.04	0.13	0.61	0.73	...	...
24	...	...	...	...	...	...	0.13	0.33	0.05	0.05	...	...
25	...	...	...	0.62	...	0.02	0.24	0.31	1.25	...	...	...
26	...	...	...	0.02	...	0.20	0.23	0.36	...	0.01	...	...
27	...	...	...	0.14	...	...	0.35	0.23	1.83	0.08	...	...
28	...	...	...	...	...	...	0.04	0.35	0.80	...	...	...
29	...	...	...	...	...	0.05	0.03	0.06	0.66	...	...	...
30	...	...	0.10	...	...	0.02	0.03	0.06	0.52	...	...	...
31	...	...	...	...	...	...	0.03	0.06	...	...	...	...
Total.	...	1.08	0.10	0.78	...	4.63	1.97	3.15	6.15	5.07	2.82	...

Whole total ... 26.55

## Statement of Rainfall in the year 1918.

	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1	...	...	...	...	...	0.03	...	0.02	0.12	...	...	...
2	...	...	...	...	...	0.03	...	0.06	...	...	...	...
3	...	...	...	...	...	0.01	...	0.21	...	0.11	...	...
4	...	...	...	...	...	...	0.55	0.24	0.02	0.05	...	0.10
5	...	...	0.07	...	...	...	0.63	0.06	...	0.41	...	...
6	...	...	...	...	...	...	0.22	0.01	...	...	...	...
7	...	...	...	...	...	...	...	0.06	...	...	0.17	...
8	...	...	...	...	...	...	...	...	...	...	0.23	...
9	...	...	...	...	0.24	...	...	...	...	...	...	...
10	...	...	...	...	...	...	...	...	...	...	...	...
11	...	...	...	...	0.23	...	...	0.02	...	...	...	...
12	...	...	...	...	0.50	...	...	0.03	...	...	...	...
13	...	...	0.35	...	...	...	...	0.02	...	...	...	...
14	...	...	0.01	...	0.14	...	...	0.02	...	...	...	...
15	...	...	...	...	0.31	...	...	0.02	...	...	...	...
16	...	...	...	...	0.05	...	...	0.02	...	...	...	...
17	...	...	...	...	...	...	...	0.53	1.45	...	...	...
18	...	...	...	...	...	...	...	0.12	...	...	...	...
19	...	...	...	...	...	...	...	0.03	...	...	...	...
20	...	...	...	...	...	0.13	...	0.12	0.03	...	...	...
21	...	...	...	...	...	...	...	0.20	...	...	...	...
22	...	...	...	...	...	...	...	0.10	...	...	...	...
23	...	...	...	...	1.70	...	0.03 $\frac{1}{2}$	0.19	...	...	...	...
24	...	Slight.	...	...	0.02	...	...	0.05	1.14	...	...	...
25	...	...	...	...	0.10	...	...	0.02	...	...	...	...
26	...	...	...	...	...	...	...	...	...	...	...	...
27	...	...	...	...	...	...	...	...	...	...	...	...
28	...	...	...	...	...	...	0.02	...	...	...	...	...
29	...	...	...	...	...	...	...	...	...	...	...	...
30	...	...	...	...	...	...	...	...	...	...	0.06	...
31	...	...	...	...	...	...	0.03	0.01	...	...	...	...
Total	...	...	0.43	...	3.29	0.19	1.48 $\frac{1}{2}$	2.16	1.76	0.57	0.46	0.10

## Statement of Rainfall in the year 1919.

	Jan.	Feb.	March.	April	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1	...	...	...	...	...	...	0.62	0.05	0.05	0.17	...	...
2	...	...	...	...	...	...	0.26	0.12	0.08	0.16	...	...
3	...	...	...	...	...	...	0.55	0.36	0.36	0.11	...	...
4	...	...	...	...	...	...	0.07	0.14	0.09	...	0.78	...
5	...	...	...	...	...	...	0.04	0.11	0.04	...	...	...
6	...	...	...	...	...	0.04	...	0.10	0.01	...	...	...
7	...	...	...	...	...	0.14	0.17	0.09	0.10	...	...	...
8	...	...	...	...	...	0.86	1.10	0.10	...	...	...	...
9	...	...	...	...	0.46	0.49	0.05	...	...	...	...	...
10	...	...	...	...	...	...	...	...	...	...	...	...
11	...	...	...	...	...	...	0.04	...	...	...	...	...
12	...	...	...	...	...	...	0.04	...	...	...	...	...
13	...	...	...	...	0.21	0.04	...	...	...	...	...	0.09
14	...	...	...	...	0.65	0.34	...	...	...	...	...	...
15	...	...	...	...	...	0.23	...	...	...	...	0.13	...
16	...	...	...	...	...	...	...	...	1.41	...	...	...
17	...	...	...	...	...	...	...	...	0.07	...	...	...
18	...	...	...	...	...	...	...	...	0.19	...	0.22	...
19	...	...	...	...	...	...	...	...	0.31	...	0.74	...
20	...	...	...	...	...	...	0.02	...	...	...	...	...
21	...	...	...	...	...	...	0.15	...	0.23	...	...	...
22	...	...	...	...	...	...	...	...	0.05	...	...	...
23	...	...	...	...	...	...	...	0.52	1.47	...	...	...
24	...	...	...	...	...	...	...	0.33	...	...	...	...
25	...	...	...	...	...	0.04	0.19	0.53	0.68	...	...	...
26	...	...	...	...	...	...	0.04	0.29	0.04	...	...	...
27	...	...	...	...	0.70	...	0.39	0.07	1.01	0.27	...	...
28	...	...	...	...	1.35	0.10	1.59	0.03	2.78	0.18	...	...
29	...	...	Slight.	...	...	...	0.13	0.20	0.18	...	...	...
30	...	...	0.35	...	...	0.02	0.13	0.22	3.27	...	...	...
31	...	...	...	...	1.19	...	0.14	0.93	...	...	...	...
Total	...	...	0.35	...	4.56	2.35	5.67	4.33	9.42	6.89	1.87	0.09

## Statement of Rainfall in the year 1920.

	Jan.	Feb.	March	April	May.	June.	July.	August	Sept.	Oct.	Nov.	Dec.
1	...	...	...	...	...	0·07	...	0·50	...	...	...	...
2	...	...	...	...	...	0·16	...	0·49	...	...	...	...
3	...	...	...	...	...	...	...	0·23	...	...	...	...
4	...	...	...	...	...	...	...	0·12	...	...	...	...
5	0·15	...	...	...	...	...	0·04	0·04	0·04	...	...	...
6	...	...	...	...	...	1·95	0·09	0·39	...	...	...	...
7	...	...	...	...	...	0·16	0·35	...	...	...	...	...
8	...	...	...	...	...	...	1·66	...	...	...	...	...
9	...	...	...	...	...	0·02	0·53	...	...	...	...	...
10	...	...	...	...	...	...	0·30	...	0·02	...	...	...
11	...	...	...	...	...	0·20	0·25	0·04	...	...	...	...
12	...	...	...	...	...	0·44	0·18	0·05	0·25	...	...	...
13	...	...	...	...	...	0·53	0·30	0·03	0·03	...	...	...
14	...	...	...	...	...	0·03	0·09	...	...	...	...	...
15	...	...	...	...	...	0·09	0·05	0·08	...	...	...	...
16	...	...	...	...	...	0·37	0·32	...	...	...	...	...
17	...	...	...	0·01 $\frac{1}{2}$	...	...	0·12	...	...	...	...	...
18	...	...	...	...	...	...	0·12	...	...	...	...	...
19	...	...	...	...	...	0·03	0·02	...	0·35	0·11	...	...
20	...	...	...	...	...	...	0·14	...	1·23	0·05	...	...
21	...	...	...	...	...	0·05	0·06	...	0·97	...	...	...
22	...	...	...	...	...	...	0·26	...	0·48	...	...	...
23	...	...	...	...	...	...	0·24	...	0·21	...	...	...
24	...	...	...	...	...	...	0·19	...	0·08	...	...	...
25	...	...	...	...	...	0·03	0·04	...	0·10	...	0·07	...
26	...	...	...	...	...	0·03	0·20	...	...	...	...	...
27	...	...	...	...	...	0·03	0·16	...	0·51	...	...	...
28	...	...	...	...	...	...	0·16	0·01	0·02	...	...	...
29	...	...	...	...	...	...	0·02	...	0·52	...	...	...
30	...	...	...	...	...	...	...	0·04	...	...	...	...
31	...	...	...	...	...	...	0·27	0·11	...	...	...	...
Total..	0·15	...	...	0·01 $\frac{1}{2}$	...	4·31	6·43	2·43	4·81	0·16	0·07	...

## Statement of Rain fall in the year 1921.

	Jan.	Feb.	March	April.	May.	June.	July.	August	Sept.	Oct.	Nov.	Dec.
1	...	...	...	...	...	...	...	...	0-03	0-17	...	...
2	...	...	...	...	...	...	...	0-07	0-03	...	0-09	...
3	...	...	...	...	...	...	...	0-01	0-02	...	...	...
4	...	...	...	...	...	...	...	0-20	0-03	...	...	...
5	...	...	...	...	...	...	...	0-04	0-05	...	...	...
6	...	...	...	...	...	...	...	...	...	0-35	...	...
7	...	...	...	...	...	...	...	...	0-01	0-52	...	...
8	...	...	...	0-37	...	...	0-79	0-21	...	...	...	...
9	...	...	...	...	...	0-28	...	0-01	...	...	...	...
10	...	...	...	...	...	0-20	...	0-12	...	0-24	...	...
11	...	...	...	...	...	...	...	0-23	...	...	...	...
12	...	...	...	...	...	...	...	0-09	...	0-14	...	...
13	...	...	...	0-92	...	...	...	0-12	...	...	...	...
14	...	...	...	...	...	...	0-92	0-10	...	...	...	...
15	0-10	...	...	...	...	0-17	0-24	0-09	...	...	...	...
16	...	...	...	...	...	...	...	0-12	...	...	...	...
17	...	...	...	...	...	...	...	0-10	...	...	...	...
18	...	...	...	...	...	...	...	...	0-40	...	...	...
19	...	...	...	...	...	...	0-06	0-10	0-38	...	...	...
20	...	...	...	...	...	0-35	...	0-08	0-01	...	...	...
21	...	...	...	...	...	...	0-03	...	...	...	...	...
22	...	...	...	...	...	...	0-21	0-02	...	...	...	...
23	...	...	...	...	...	...	1-27	...	...	0-07	...	...
24	...	...	...	...	...	...	2-05	...	...	...	...	...
25	...	...	...	...	...	...	1-72	...	...	...	...	...
26	...	...	...	...	...	...	0-50	...	...	...	...	...
27	...	...	...	...	...	...	0-21	0-08	...	...	...	...
28	...	...	...	...	...	...	1-00	...	...	...	...	...
29	...	...	...	...	...	...	0-69	...	...	...	...	...
30	...	...	...	...	...	...	0-07	...	...	...	...	...
31	...	...	...	...	...	...	0-05	0-01	...	...	...	...
Total	0-10	...	...	1-29	...	1-00	9-73½	1-86	1-01	1-49	0-09	...

Grand Total ... 16-62½.