The plants which possess this power of abstracting *nitrogen* direct from the air, are those belonging to the natural order Leguminosæ, to which order belong peas, beans, vetches, clover, sainfoin, lucerne, &c. On the rootlets of the plants of this order* are a large number of small nodules, or tubercles. These are the home of micro-organisms capable of abstracting free nitrogen from the air, and forming nitrogenous compounds. The greater portion of this nitrogen ultimately finds its way into the plant, and is there made use of.

The benefit is not confined to the leguminous crop alone, but where that crop is ploughed in, or even if only the roots are left, the soil becomes so enriched by the accumulated nitrogen that greatly increased crops result.

Dr. Wagner, of Darmstadt, conducted experiments to test the effect of the above. Two equal plots were taken, and upon one, white mustard, and on the other, vetches were ploughed in, and oats sown. Each received an equal dressing of artificial manure, but the yield on that where vetches had been ploughed in was twice that on the one where white mustard had been ploughed in.

Similar experiments were conducted by Heiden, rye being taken (1) after lupines, ploughed in, and (2) after bare fallow. The relative yields of the plots were: plot 1—96 of grain and 205 chaff and straw; plot 2—56 of grain and 114 chaff and straw.

The importance of this fixation of free nitrogen cannot be over-estimated; as it provides a large quantity of the dearest manurial constituent without cost. 2. The food added to the soil by green manuring cannot readily be lost by drainage. This explains the advantage which light land derives from it, that class of land not usually being retentive of plant food. 3. A large quantity of humus is added to the soil, the benefit of which has already been noticed. 4. During decomposition of the vegetable matter, mineral matters are rendered available for plant-food, owing to the effects of the products of decomposition.

TROPICAL FODDER GRASSES.

The following tropical grasses are selected as possessing special merits for fodder purposes. Amongst them are plants suitable for almost every condition found in tropical countries. The list has had the advantage of the revision of Sir Joseph Hooker, who is now working out the grasses of British India and who has suggested some emendations of the commonly accepted nomenclature.

Anthistiria australis, *R. Brown.*—The well-known "Kangaroo grass" of Australia, but widely distributed throughout Southern Asia and the whole of Africa. A perennial upright grass over 3 feet in height. It enjoys a wide reputation and is regarded as the most useful of the indigenous grasses of Eastern Australia, stock of all descriptions being remarkably fond of it. The roots are strong, and penetrate the soil to a great depth, so the plant remains green during the greater part of the summer. In the autumn the foliage turns brown, when, however, its nutritive qualities are said to be at the highest. If cut as soon as the flower stem appears it can be made into excellent hay. The most reliable way to propagate this grass is by division of the roots. It perfects very little seed (Turner).

Anthistiria avenacea, *F. v. Mueller.*—"Tall oat-grass" of New South Wales. A nutritious perennial pasture grass, often rising to a height of 4 to 5 feet. It grows generally in tussocks, and prefers rich soils, where its roots can penetrate deeply into the ground. It thus can withstand long spells of dry weather with impunity. It yields a large amount of bottom fodder, and is regarded by Bailey as "one of the most productive grasses of Australia." It possesses the advantage of seeding freely. Turner remarks "it might be profitably cultivated for ensilage, especially if it were cut before the flower stems become hard and cane-like."

Astrebla pectinata, *F. v. Mueller.*—Widely distributed in dry regions inland in North and East Australia. Closely allied to "Mitchell grass," but usually not so tall. A perennial desert grass, resisting drought, and sought with avidity by sheep, and very fattening to them and other pasture animals. Seeding freely (Mueller).

Astrebla triticoides, *F. v. Mueller* (Danthonia triticoides, *Lindl.*).—The "Mitchell grass" of Australia. A very valuable perennial grass with glaucous green leaves. On rich soils it produces a great amount of rich herbage, of which stock of all kinds are remarkably fond. Cattle are said to fatten on this grass even when it is much dried up during periods of drought. If cut when about to flower it makes excellent hay. Turner "thoroughly recommends it for permanent pastures." The land should, however, be well drained.

Cynodon Dactylon, *Pers.*—A prostrate perennial grass with very narrow glaucous green leaves. It is widely distributed in all hot countries, and extends also into temperate regions. It passes under various names, such as "Bahama grass," "Bermuda grass," "Indian couch grass," "Doub," and "Doorva." It is an important grass for covering bare, barren land, and for making smooth, compact lawns. It resists extreme drought, and once established in cultivated land it is very difficult to eradicate. It is easily established by planting small portions of the rooting stems about 8 inches apart. If done at the beginning of the rainy season the ground will be completely covered in six weeks. It may also be propagated by seeds, which are now readily obtained in commerce. It should, however, never be planted except in places where it is required to remain permanently. When grown specially for fodder, in enclosed paddocks, it yields three or four crops in the year, and makes excellent hay. In very dry seasons in the West Indies animals exist almost entirely on the underground rhizomes of this grass.

The following note on the use of Bahama grass for making lawns in India is taken from Firminger's *Manual of Gardening for Bengal and Upper India* [Calcutta, 1874] p. 26:—"The grass principally used for lawns in this country is that called Doob-grass (*Cynodon Dactylon*), a plant of trailing habit, not growing high, and when in vigorous growth of a soft dark green hue. It thrives where scarcely any other kind will, and delights in the edges of frequented highways. The spot it seems to like especially

* All the plants? The Cæsalpineæ must, surely, be excepted.

is where brick and lime rubbish has been thrown and trodden down hard. It will also grow in the poor soil beneath the shade of trees, where other grasses grow but scantily, if at all. When required for lawns a sufficient quantity can easily be collected from the roadside and waste places. The piece of ground intended for lawn should be well dug, and then made perfectly level and smooth. Drills should then be drawn over it a foot apart, in which little pieces of the roots should be planted out at the distance of half-a-foot from each other, and the ground afterwards watered occasionally, till the grass has become thoroughly established. In Bengal further watering will be unnecessary, but in the upper provinces irrigation during the hot season is indispensable, as otherwise the grass would soon become scorched up and perish.

"A more expeditious and very successful plan of laying down a lawn, sometimes adopted, is to pull up a quantity of grass by the roots, chop it tolerably fine, mix it well in a compost of mud of about the consistency of mortar, and spread this out thinly over the piece of ground where the lawn is required. In a few days the grass will spring up with great regularity over the plot."

Eragrostis abyssinica, *Link.*—A slender annual grass, known in Abyssinia as "Teff," "Tcheff," or "Thaff." It is indigenous to the higher lands, and is cultivated for the sake of its grain all over Abyssinia. There are several varieties, some depending on the height of the plant, others on the colour. According to Richard, there are green, white, red, and purple Teffs. The grain crop requires four months to ripen. "In good years it returns 40 times the seed, and only 20 times in bad years." The flour of teff is very white, and produces bread of excellent quality. Seed of teff was obtained by Kew in 1886, and distributed to numerous establishments in India and the Colonies (*Kew Bulletin*, 1887, January, pp. 2—6). The plant prefers light sandy soils, and adapts itself even to the most sandy; it then produces slender wiry stems, and supports a large weight of ear. The grain is reported to make "an excellent fine hay" in British Guiana, and to mature in six or eight weeks from the time of sowing. "For this purpose teff is well worth cultivating. It is cleaner and brighter looking than any other grass, and is readily eaten by cattle and horses." The reports from Australia and India are equally favourable. The value of this plant for fodder purposes is exceptionally high. Its chief merits in this respect are the short time it takes to mature, and its suitability to thrive in dry, sandy regions, where few other grasses would flourish equally well.

In the Proceedings of the Agri.-Hort. Society of India, 1888, p. lxxii., the following note appeared:—"The seed of this new cereal was received from Kew, and was distributed as noted in the *Proceedings* of May last. Mr. C. C. Stevens, Commissioner of Chota Nagpore, now writes: 'You will remember having given me a small packet of seed of "tcheff" for experiment. I gave it to the Rajah of Jashpore, who had it sown in two or three different localities. He has not given me very precise information, but I understand that the seed was treated exactly like the ordinary rainy weather crops. He tells me tha he has saved some three or four seers of seed, and that the hill people have taken a fancy to the crop. The best thing he can do is to keep the seed and sow next season. He has sent me a bundle of plants, which I shall forward to you when a favourable opportunity occurs. The straw or grass is 4 feet or 4½ feet in length, and smells sweet.' As only about 2 ounces of the seed was supplied to Mr. Stevens, the results obtained appear very satisfactory for the first season, and if the crop is found suitable there should be no difficulty in establishing it next season."

A very full account of teff is given by Mr. J. F. Duthie, F.L.S., in the Report of the Saharunpur Gardens for the year 1888, pp. 11-12. The following extracts are of interest:—

"Seeds of this grass were sent to us last year by the Director of the Royal Gardens, Kew, with the remark that it was an Abyssinian food-grain which might prove useful for India. I have a bad opinion of it as a food-grain, but think better of it as a fodder, and have therefore classed it under the head of 'fodder plants.'

"Teff consists of two varieties, one with white seeds and the other with red seeds. The white-seeded kind is said to be cultivated in Abyssinia during the dry season and the red during the rains. We tried the two kinds here during both seasons, and found, as stated, that the white answered best for the dry season and the red for the wet.

"Three sowings were made of the two kinds—the first in March, the second in April, and the third in July. The March sowing of the white variety gave an out-turn of grain at the rate of 660 lbs. per acre, while the red variety, sown on the same date, only resulted in an out-turn of 17 lbs. per acre. The crop was cut in the beginning of May, but sprang up again into a second growth and yielded a cutting of green fodder early in the rains. The note made regarding the weight of this cutting has, unfortunately, been mislaid, and I am therefore unable to give its approximate weight per acre.

"The April sowing of the white variety produced no grain, and the sowing of the red variety made at the same time only returned 11 lbs. of grain per acre. Both kinds, however, gave a good crop of fodder in the middle of July, the red variety producing 11,022 and the white 7,436 lbs. per acre. The cutting was in a half-dried state when weighed, or the figures would have amounted to a greater total.

"The July sowing of the white variety gave an out-turn of 11 lbs. of grain per acre, and the sowing made on the same date of the red resulted in an out-turn of 82 lbs. per acre. These out-turns may be looked upon as failures, and conclusively prove that teff is of no great account for cultivation on the plains as a food grain. A cutting was made across a section of the two plots of this July sowing in the middle of August, and weighed collectively in its green state, and as a result gave an out-turn of 16,000 lbs. of green fodder per acre. The out-turns of 3,116 and 2,676 lbs. noted in the statement for part of this plot really mean the out-turn of dried hay, as the fodder was weighed in the beginning of October, and was then crisp and dry. A rainy season sowing of teff may, therefore, be looked upon as capable of producing 16,000 lbs. of green

fodder and from 2,000 to 3,000 lbs. of dried hay per acre.

"A sowing of ½ lb. of each kind was made at Arnigadh in the beginning of the rains, and resulted in a collective out-turn of 40 lbs. of grain. This was a remarkably good yield for the small quantity of seed sown, and proves that in hill tracts teff may yet prove a prolific food grain.

"The hay made from the teff was of exceptional good quality and was greedily eaten by the garden bullocks. When it was offered to them they were being fed upon jowar or sorghum stalks, and, as is well known, these are remarkably sweet, and cattle, when fed upon them, generally refuse other kinds of dry food until they find that sorghum is not forthcoming. Our garden cattle, however, seemed to prefer the teff hay to the sorghum, as they would not touch the latter until they had devoured the whole of the teff placed before them.

"The experience gained here in the cultivation of teff during the past year may therefore be summed up as follows:—

"When sown in the dry season it will yield a light crop of grain, and when sown in the rains it yields little or no grain, but produces abundance of green fodder which may be cured into very palatable hay where the latter is preferred. In my opinion, teff is destined to become the rye grass of India, and is well worthy of more extended trial on some of the Government fodder reserves."

Euchlæna luxurians, *Miers* (Reana luxurians, *Durieu*). "Teosinte." An annual grass of large size from Guatemala allied to the maize. The first published illustration of the plant was given in the *Botanical Magazine*, tab. 6,414. It attracted a good deal of attention about 20 years ago as a fodder plant (see *Kew Reports*, 1878, 1879 and 1880). Seeds of it were widely distributed from Kew to the East and West Indies, Australia, and tropical Africa. It is a tall, densely-tufted grass, sometimes reaching 15 feet in height, the stems are as thick as the thumb at the base, and the leaves 3 to to 4 feet long, by 2 or 3 inches broad. Dr. Schomburgk in 1880 wrote from the Adelaide Botanic Garden, S. Australia: "I have now cultivated Teosinte for three years, and it is one of the most prolific fodder plants."

Mr. W. R. Robertson, Agricultural Reporter to the Government of Madras, wrote as follows in July 1883:—"A small plot was sown with this crop; the out-turn of green fodder was at the rate of 38,400 lb. per acre, a very large out-turn; but, the cost of production was great, for it was necessary to irrigate the land nearly every other day, from sowing until harvest. *Reana* is undoubtedly a very heavy producer, crops grown on the farm have given enormous yields, but further experience confirms the opinions expressed regarding the crop in the last report: 'On good soils, under liberal treatment, when it can obtain plenty of rain or irrigation water, the crop grows most rapidly and luxuriantly; but it cannot withstand a drought. Indeed, the experiments made showed that a drought, which scarcely affected the *Sorghum* crops, was sufficient to check the growth of the *Reana* to such an extent as to render it useless to keep the crop standing longer. As a fodder crop in a damp warm climate, or where irrigation can be secured, it is well worthy of attention. There is perhaps no other crop, sugar cane excepted, which will produce such an enormous quantity of green plant per acre, but the fodder is very watery, and does not appear to be very palatable to stock when offered for the first time. The watery juices of the stem seem to be destitute of saccharine matter during all stages of growth."

The following account of the grass was given in the R port of the Botanic Garden at Bangalore for the year 1888-9, p. 13:—"Teosinte or buffalo grass. With rich cultivation this noble grass affords an inexhaustible supply of fodder for cattle. In special instances the stalks have been known to attain a height of 18 feet, but in ordinary cultivation they are usually 6 to 8 feet, with a small colony of offsets rising up from the base of each parent stalk. Seed was first received from Mr. Blechynden, Honorary Secretary to the Agri-Horticulturrl Society of India, and in the subsequent year (1878-79) the following particulars of cultivation appeared in the Annual Report of the Garden:—

"The forage plant *Euchlæna luxurians* has been grown experimentally on a small scale. 19 square yards of highly manured land produced 288 lbs. of dry fodder and 19 lbs. of seed. The object in culture was chiefly to obtain seed to meet the demands of correspondents, and to enable me to sow a larger piece of ground if Government should wish to extend the experiment. Cattle and horses are fond of the green grass, and I think it will be a good addition to the green forage crops of the monsoon season. At any other time the crop would require irrigation, and I have a small field now under this method of culture, which will be reported on when the results are fully known."

Subsequent cultivation confirmed the truth of the above remarks, and the great value of Teosinte as a food plant has been established in many parts of India. It should be grown on all land holdings where there are horses, cows, and bullocks to be fed. If, during the dry season, small plots are raised along the channels, and in spare nooks and corners, the condition of live stock would be better maintained than we usually see it.

The latest reports of Teosinte are as follows:—In a Report on *Agricultural Work at British Guiana* for the years 1891-92, p. 68, Messrs. Harrison and J nman give interesting particu'ars as under:—*Teosinte* is an annual, but readily reproduces itself on good land from the seed shed. It soon dies out, however, on impoverished land. Though an annual, in the season of growth, if reaped young but not too short, the stubble quickly springs again, and a second and third crop can be thus taken in favourable weather. It should be sown *in situ*, and the plants thinned out as much as is necessary to give each one 9 to 12 or 16 square feet of superficial space, as it does not bear transplanting, under which the yield is poor. The following is an analysis of the seed:—

Water	12·75
Fats	3·94
* Albuminoids	9·94
† Amides, &c.	1·00
Pectose, gum, &c.	8·22
Starch	37·38
Digestible fibre	16 46
Woody fibre	9·67
Mineral matters	2·44
	100·00 (*sic.*)

* Containing nitrogen - 1·59
† " " - ·16

The grain of this grass, from its composition, possesses a fair value, although the proportions of fibre present are somewhat high.

In the *Journal of the Agri-Hort. Society of India*, 1894, p. 78, it is stated :—"A very good crop was raised this season. After the stalks had reached a height of about 5 feet, they were cut down to within 1 foot of the ground; three weeks later a second crop was ready for cutting, varying in height from 18 inches to 3 feet; a third crop was cut a month later, and yielded stalks about 2 feet high; in this manner three good cuttings were made in four months. It was found that from 4½ to 5 lbs. of seed were sufficient to sow an acre. The fodder is greatly relished by cattle."

At Lagos, on the West Coast of Africa, Mr. Millen has successfully introduced "Teosinte" as a fodder plant, and in June 1894 wrote: "I have planted a quantity of plants of *Euchlæna luxurians*; it is the only fodder plant of those introduced which appears to be growing with good results."

At Saharanpur, in the *Report* for 1893 just issued, Teosinte is mentioned as having suddenly grown into demand as an annual forage grass, and seed has been harvested to meet all possible demands.

ZOOLOGICAL NOTES FOR AGRICULTURAL STUDENTS.

Quadrumana.—The characteristics of the members of this order are the following :—The hallux (innermost toe of the hind limb) is separated from the other toes, and is opposite to them, so that the hind feet become prehensile. The pollex (innermost toe of the fore limbs) may be wanting, but when present is usually opposite to the other digits. To this order belong the apes, monkeys, baboons, lemurs, &c.

The last order of the mammalia is *Bimana*, and as it comprises man alone, it hardly requires notice here, since the peculiarities of man's mental and physical structure belong to other branches of science.

Postscript.—These notes were commenced in our issue of July 1892, and were originally intended only for the students of the Colombo School of Agriculture. The subject of Zoology—in its relation to agriculture—must, however, needs be of great interest to students of agriculture, who need not all be students of an Agricultural School or College, and for this reason and in order that the notes may be collected and presented in a convenient form to all who may wish to study or consult them, the writer will endeavour to find time to revise and publish them in hand-book form.

THE COSSIPORE INSTITUTION.

The following extract from the report of the Cossipore Practical Institution of Horticulture, Floriculture and Agriculture for 1893, deals with the practical operations carried on in the Institution's Gardens, and contains much information of a useful nature, which will be interesting reading to students of agriculture in Ceylon. In congratulating the Superintendent (from whom we have also received a Report of Sixth Flower Show held in February, 1894) on the excellent work done by the Institution, we can only express a hope that some from among our wealthy native gentry may be induced to follow the example of the philanthropic founder of the Cossipore Institution :—

Now let us turn to offer a few remarks regarding the improvements made upon the resources of the Gardens and Experimental Farms of the Institution during the year under review. We are glad to note that the quantity of flowering and ornamental plants and fruit grafts of various descriptions, added to the stock of the gardens, exceed the collection of former years. These were all indented to benefit the students, who by propagating the plants, might learn the various methods of multiplication, and also their nature and treatment from the first stage of development. Here we may add that we have acquired a plot of land directly to the west of the Cossipore Garden, for the purposes of extending of Rosary and making agricultural experiments. This addition has been put in hand by the Executive Committee simply for the reason, that, for want of a proper field to experiment upon near Cossipore, most of the students have found difficulty to learn agriculture, as they had to go to our distant farms at Ultadanga and Shankhyanagar.

In agricultural matters,—the necessity for increasing the quantity and improving the quality of the crops have become strongly felt in our country; and they have always engaged the attention of the Institution most closely during the past years. We have, therefore, shown much zeal in setting examples to the cultivators by way of improving the soil grown exhausted by the same and uniform methods of tillage, and introducing recent systems most suited to the resources of the country. In our Experiment Farms of Cossipore, Ultadanga, and Shankhyanagar where every year larger areas have been brought under cultivation, we have attempted the cultivation of some crops such as paddy, tobacco, radish, peas, cabbages, cauliflowers, onions, garlic, beet, carrot, beans, parbar, mustard, moosooree, oats, gram, Thikra kalai, Indian corn, &c., according to our own way; and the results arrived at were more or less satisfactory. As regards fibrous plants, we may add that we have cultivated Boehmeria nivea, Sida rhomboidia, Malachca capitata, and Hibiscus abelmosehus. All of these are indigenous to this country; and most of them may be turned to profitable account. We tried similar experiments with jute and hemp on a somewhat larger scale, extending over many bighas of land in our Experimental Farm of Shankhyanagar; but