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SCHOOL OF AGRICULTURE
UNIVERSITY OF NEW ZEALAND

THE SCHOOL GRASS PLOT

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Many sources are available for keys to the identification of grasses and clovers. This key which is used at Lincoln College is not intended solely for identification purposes but rather that teachers in planning and establishing a garden plot for teaching purposes may be able to group their specimens together so that those which are difficult to distinguish may be more readily identified.

An example of this may be seen in the grouping of hairless clovers in one row. Thus there will be white clover, strawberry clover, alsike clover, suckling clover and clustered clover. The first part of the row will contain the creeping, hairless clovers, namely white and strawberry. When seen side by side the differences in leaf shape and colour will stand out. Similarly the remainder of the row would contain the hairless erect clovers—alsike, suckling, and clustered so that their differences could be more readily demonstrated. The adjoining row would contain the hairy clovers and similarities and differences between the plants in the two groups could also be discussed. Red clover and alsike clover show points of similarity but the presence or absence of hairs and the shapes of the stipules are clear points of identification.

It will be noted that among the grasses some occur in more than one group. This is intentional so that grasses which have some points in common may be grouped together. Thus Yorkshire fog occurs in Group 1: Grasses with definite colours at the base of the sheath, and again in Group 4: Hairy grasses.

In distinguishing the grasses there are some terms which are necessary. The name "ears" has been retained rather than the more scientific "auricles." The terms should be explained and adequately demonstrated. For this purpose the ears of barley are very prominent; the ligules of *Phalaris tuberosa,* timothy and prairie grass show up well for demonstration purposes. Other features such as the canoe-shaped tip of the leaf in the *Poa* species, the shoulder projections of Chewings fescue and the cutting edge of tall fescue can be discussed as the need for them arises.

With the clovers and clover-like plants the term stipule is indispensable and these can best be demonstrated on red clover, lucerne and Lotus major.

IDENTIFICATION OF GRASSES AND CLOVERS

CLOVERS AND ALLIED PLANTS

GROUP I.—**True Clovers:** Stipules membraneous and transparent. Leaflets with stalks of equal length (except suckling and hop trefoil)—

A. Hairy.

1. Stipule pointed with tuft of hairs. Plant erect.	**Red**
2. Stipule sharp pointed. Plant spreading.	**Knotted**
3. Stipule blunt.	**Crimson**
4. Stipule almost enclosing the stem. Leaflets sometimes spotted.	**Subterranean**
5. Greyish downy leaves. Flowers pinkish.	**Haresfoot trefoil**

B. Hairless or nearly so.

1. Creeping stems	
(a) Leaflets round or heart-shaped.	**White**
(b) Leaflets long oval.	**Strawberry**
2. Erect stems.	
(a) Stipules long pointed.	**Alsike**
(b) Stipules short.	**Clustered**
(c) Stalk of central leaflet longer.	**Suckling (little trefoil)**
(d) Like suckling. Flower heads like small hops.	**Hop trefoil**

GROUP II.—**Medicks:** Stipules green over half the area. Centre leaflets on longer stalk. Spike produced from end of leaflet.—

A. Leaflets oval. Downy on back. Toothed on upper half.	**Lucerne**
B. Leaflets heart-shaped or round	
1. Hairy. Pods small, black.	**Black medick**
2. Few or no hairs. Pods large, yellowish. No spots on leaflets.	**Burr clover**
3. Similar to 2 above but leaflets spotted.	**Spotted burr clover**

GROUP III.—**Lotus or Birdsfoot Trefoil:** Stipules like leaflets so that plant appears to have 5 leaflets. Flowers yellow.—

A. Hairless, 5-10 florets in head.	
1. Upright stems. Found in moist places.	**L. major (syn. uliginosus)**
2. Prostrate stems. Dry places.	**L. corniculatus**
B. Hairy, less than 5 florets in head.	
1. 3-4 florets. Long peduncles.	**L. hispidus**
2. 1-2 florets. Short peduncles.	**L. angustissimus**

GROUP IV.—**Melilots:** Stipules narrow but green. Central leaflets on longer stalk. No spike from end of midrib. Leaf thick, hairless, serrated along entire edge.

Yellow flower.	**Sweet clover**
White flower.	**Bokhara clover**

PERENNIAL OR BIENNIAL GRASSES

GROUP I.—Grasses with definite colours at base of sheath:

A. With red coloration.	
1. With leaf folded in bud.	Perennial rye
2. With leaf rolled in bud.	
(a) Slightly round edge.	Italian rye
(b) Strongly cutting edge.	Tall fescue
B. With red and white veins.	Yorkshire fog
C. With yellow colour under brown.	Dogstail
D. With purplish-brown base.	
(a) Bulb-like swellings at base. Late flowering.	Timothy
(b) Short rhizomes. Early flowering.	Foxtail

GROUP II.—Grasses with swollen underground joints:

A. One or two swollen white joints: round sheath: otherwise much like cocksfoot.	Timothy
B. Several small pink joints: bluish leaf: very long ligule.	Phalaris tuberosa
C. Many much swollen onion-like joints. Hairy leaf.	Onion twitch

GROUP III. Grasses with rhizomes (twitches):

A. With ears.	Long twitch (old man)
B. Without ears.	
1. Covered with velvety hairs.	Creeping fog
2. Hairs scattered or absent.	
(a) Leaf folded.	
1. Blades with canoe shape tips.	
(a) On dry land.	Poa pratensis
(b) In water.	Floating sweet grass
2. Blades cigar shaped.	Paspalum
(b) Leaf rolled.	
1. Blades tapering from base to tip.	Agrostis spp.
(i) Leaves ¼in. wide at base. Ligule 1/16in. Flower heads angled where secondary branches arise. Rhizomes slender and usually short.	Brown top
(ii) Leaves ⅜in. wide. Ligule ¼in. and frayed. Flower heads not angled. Rhizomes long producing more open sward than above species.	Red top
(iii) Trailing overground stems. Ligule long and pointed but not frayed. Usually bent flower stalk. Flower more spike-like than (i) or (ii).	Creeping bent
2. Narrow bristle blade. In fields, 4 to 6 inches high.	Chewings fescue
3. Blade rolled into narrow pipe. Very long ligule.	Marram grass

GROUP IV.—**Hairy Grasses:**

A. Hairs on leaf or sheath or both but not longer round the ligule than elsewhere.	
1. Hairs thick on leaf and sheath.	**Yorkshire fog and Creeping fog**
2. Hairs on sheath only.	**Prairie grass**
3. Hairs on blade chiefly and these hairs in lines. Few if any on sheath.	**Tall oat and Onion twitch**
4. Leaves and sheath hairy. No red and white veins, and hairs not in lines.	**Goose grass and Barren brome**
B. Hairs present or absent on leaf, but always long, silky hairs round ligule.	
1. No ligule; strong tufts of hair.	**Danthonia**
2. Ligule and a few hairs: no rhizome.	**Sweet vernal**
3. Ligule and a few spiky hairs.	**Paspalum**

GROUP V.—**Grasses with leaves folded in the bud:**

A. With canoe shaped tips to blades.	
1. With rhizomes	
(a) growing in water.	**Floating sweet grass**
(b) on dry land.	**Poa pratensis**
2. Without rhizomes	
(a) Smooth flower stalk. Nearly always flowering.	**Poa annua**
(b) Rough flower stalk.	**Poa trivialis**
B. With tapering blades.	
1. Hairy sheath.	**Prairie grass**
2. Hairless	
(a) With red base of sheath.	**Perennial rye**
(b) Colourless base—long leaves.	**Cocksfoot**

GROUP VI.—**Cereals in early stages:**

A. Without ears.	**Oats**
B. With ears.	
1. Without hairs.	**Barley**
2. With hairs.	**Wheat and ryecorn**

(Ryecorn may be distinguished from wheat by the shorter ears and the hairy base of the upper surface of the leaf blade).

When these grasses and clovers have been established in the plot more detailed observations of the grasses can then be made and a fuller description obtained. An example of this is given below.

Timothy.—A grass which starts into full growth in early summer. The leaf is bluish green and the ligule long and finely toothed at the apex. The leaves are rolled in the bud. The blades are flat, indistinctly veined and rough on the margins. At the base of the leaf sheath is a single bulb-like swelling. Sometimes there are two such swellings.

In field trips this grass could then be seen as a component of a pasture when it could be noted that it grows best on heavy soils under fairly moist conditions. It is very palatable to stock and will be grazed hard leaving other grasses apparently dominating the pasture but if an area is closed from the stock it will soon dominate again.

E. LAURENCE PALMER

Dr. E. Laurence Palmer, Professor of Rural Education at Cornell University, Ithaca, New York, is now attached to Lincoln College as visiting professor at the invitation of the United States Educational Foundation in New Zealand. Dr. Palmer, who will be here until mid-October is anxious to see as much of our education system as possible especially as regard the rural schools. In addition to lecturing at this College, he will lecture for short periods at the Teachers' Training Colleges and the University Colleges. A world authority on the teaching of nature study and on the preparation of teachers in that subject, Professor Palmer comes at an appropriate time when we are attempting to implement a new scheme of nature study and are considering the whole problem of teacher training. Dr. Palmer has been supervisor of the Cornell Rural School Leaflet for the past 29 years and has written a large amount of the material appearing therein. It is a quarterly magazine devoted to the teaching of nature study and elementary agriculture in the schools of New York state but it also has a world-wide distribution. His most recent publication is "A Field Book of Natural History," an exhaustive and profusely illustrated guide to almost every field of natural history.

THE CAPILLARY THEORY OF SOIL MOISTURE

L. W. McCASKILL

(This further information is given in response to requests made as a result of the article "To Hoe or not to Hoe" in the March Bulletin.—Editor).

The recent work at Rothamsted and elsewhere seems to show that the capillary theory of soil moisture is entirely erroneous. The following notes are taken from a long article by Keen in "Endeavour" for April, 1942.

The pore space in soil is essentially of a cellular nature consisting of relatively large voids communicating with one another through relatively narrow necks. The moisture distributes itself in curved films within these cells and necks in accordance with the physical principle that it tends to reduce its free surface, and hence its surface energy, to a minimum. The pressure under a curved water meniscus is less than outside and the greater the curvature the greater is the pressure deficiency. The pressure deficiency is, therefore, a suction force which controls the filling or emptying of the cells.

The manner in which filling or emptying occurs can be seen by taking a simple case. Let a cell and its necks be full of water and suppose evaporation is taking place at one of the necks. The water level in this neck will retreat steadily until the meniscus reaches the narrowest cross-section of the neck. Here the equilibrium becomes unstable because further retreat of the meniscus carries it into a wider cross-section where a smaller pressure deficiency than the one already built up would be adequate to maintain equilibrium. Hence expansion into the cell takes place abruptly or, in other words, air suddenly enters the cell and a portion of the water is displaced to new positions.

Similarly, when the moisture content is increasing from dryness to saturation, once the thickness and curvature of the water film lining the cell and necks attain a certain value, instability sets in. The films in one or more of the necks suddenly close; the stability of the air bubble in the cell is upset and the cell becomes full of water.

One salient feature of the moisture relations is, therefore, the quantum-like movements of water associated with filling and evacuation of the cells. Another is that the emptying and filling of a cell do not occur at the same pressure deficiency. Hence regions of high and low moisture content can exist in equilibrium together. It has been

shown, too, that the water in the soil tends to resist changes, whether these are in the direction of increasing or decreasing moisture content. The water "stays put" if it can. The capillary theory taught that the drying due to absorption of the roots was met by water from moister regions moving towards the roots. The opposite is correct; the plant roots have to ramify extensively through the soil in search of moisture.

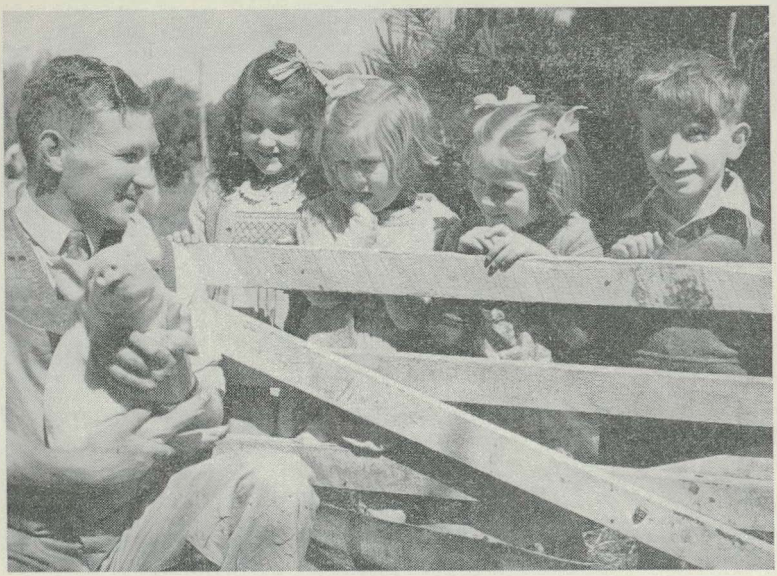
The action of rolling, then, is the purely mechanical one of compressing loose but moist soil more closely round the roots of the plant. As regards the effect of hoeing, the tendency of the water to resist changing conditions means in effect that it evaporates in situ; the dried out surface layer progressively deepens. Most soils are in fact "self-mulching," and the use of the hoe to produce a mulch is a "work of supererogation," except for those soils which tend to produce a hard crust or cap when drying and except for killing seedling weeds.

Each soil crumb can be regarded as a minute water reservoir which is actively sought out by the root hairs. The root system ranges much deeper than is usually thought and the water-holding capacity of the zone of soil traversed by plants is considerable. "A five foot depth of soil holds at least seven and a half inches of rain which, with summer rain, is ample for the transpiration needs of a good crop."

"The net results of all the work done at Rothamsted," says Keen, "is to show that provided: (1) The crop has a reasonably fair seed-bed (it has been shown that the nature of the seed bed has little influence on final yield). (2) The crop is given a hoeing in the early stages. (3) The worst of the later weeds are kept down, then any cultivation of the soil—whether before sowing or during growth—in excess of this minimum is of little direct value to the plant."

The results are in harmony with experience on the great plains of the United States and with modern knowledge of soil physics. "They are in conflict with a deeply ingrained tradition which had at least three apparently sound reasons behind it as well as the capillary theory. The first of these was that until the Industrial Revolution provided the farmer with good implements he fought a losing battle against weeds. Cultivation at every available opportunity was his only hope. Secondly, cultivation in the early stages of plant growth sometimes produces striking results and it was assumed that ultimate yield would benefit correspondingly. Thirdly, keen and successful farmers were almost always enthusiastic exponents of the art of

cultivation. Surely these leaders' farms and bank balances proved that their views were correct. But the real reason for their success lay not in the artistry of their cultivations, but in another quality for which a traditional reason also exists, 'The master's footsteps are the best manure for the land.' "



THE ANIMALS GO TO TOWN

A scene at the Shirley school, Christchurch, when Lincoln College provided ewes and lambs, calves, and a sow and thirteen piglets for nature study instruction.

When all implements were horse-drawn the results of cultivation studies had little other than academic interest. A horse costs nearly as much to keep whether working or idle so that the real costs of cultivation were negligible. But with mechanization we must realise that a tractor, well cared for, does not cost anything when idle and the more it works, the higher is the fuel, oil, and wear and tear bill. There is a powerful economic reason for a critical examination, on all types of soil, of our cultivation methods.

NATIONAL LAND POLICY

Soil Conservation Society of America

[At the third annual meeting of the Soil Conservation Society of America, the question of a national land policy was discussed. We reprint below a copy of the resolution approved and suggest it might be used as a basis for discussion regarding a land policy for New Zealand.—Editor.]

The conservation and wise utilization of natural resources is fundamental to the economic and social welfare of all people.

Land, including soil, water and the dependent living resources (cultivated crops, farm animals, forests, wild-life, range lands) is recognized as basic wealth and it must be treated in such a way that it will be made secure for permanent high productivity.

It is essential, therefore, that a National Land Policy be developed and supported by the American people, and the Soil Conservation Society of America recommends that such a policy be:—

All land should be used in a manner which will insure its continued and permanent maximum productivity and values.

To adopt and effect such a policy, the following requirements must be recognised nationally:

The conservation of soil, water and interdependent renewable resources involves scientific study and guidance, necessitating the bringing together as a single function many facets of a vast number of scientific fields. Therefore, the science of soil and water conservation is intricate and complex.

An inventory of all physical land resources and their condition is of primary importance to serve as the proper guide to the utilization and treatment of these resources.

Specifically the widespread adoption of a sound land policy should comprehend the need for conservation, development and utilization of land and water resources for: (1) sustained and improved agricultural production, (2) forest protection, re-growth and sustained yield, (3) prevention of erosion and flood damages to safeguard land from overflow and siltation, (4) protection of community and industrial water supplies, (5) maintenance of underground water sources, (6) development and installation of irrigation and drainage as needed to extend appropriate land use and conservation, (7) protection and maintenance of fish and wildlife in accordance with proper land use, (8) development and utilization of areas most appropriately suited for needed

recreational purposes, and (9) protection, and in certain cases, revegetation of areas suited to range utilization.

The ultimate goal in land use is a complete soil and water conservation programme on every farm, ranch, forest, and water shed throughout the country.

To functionalize the above land policy and the specific principles involved, the Soil Conservation Society of America recognises that:

The conservation of soil and water by efforts of the individual land-owners and operators is the most important contribution that can be made to the carrying out of this land policy. Locally and democratically organized groups of land-owners and users are the best known vehicles for carrying out soil and water conservation programmes designed to improve and perpetuate the productivity of our basic natural wealth—the land.

Private ownership of land is, for the most part, the most suitable system under which a National Land Policy can be effective. It is recognized, however, that good management, public interest and welfare necessitate public ownership and administration of certain land areas.

The technical, educational, financial and other services necessary to the adoption of a fully co-ordinated land-use programme should be thoroughly integrated and cooperatively performed, to carry out this land policy and all its principles.

Private, corporate, and allied groups have a major responsibility in obtaining adoption of this land policy and in the conservation of soil and water.

A workable method of carrying out coordinated programmes of land use, soil and water conservation requires the joint and cooperative efforts of the federal, state, and local governments which are, or may become, engaged in these endeavours. It is also necessary that the administrative forces charged with such activities be given explicit responsibilities for contributions to such coordinated programmes.

In a great measure, our national economy, our democratic process and our national security are dependent on the future conservation and use of our basic natural resources.

These proposals are therefore made in the interest of the public health, safety and general welfare of all the American people.

In order to subdue Nature you must first understand her.

—FRANCIS BACON.

RUSKIN ON GRASS

Gather a single blade of grass and examine for a minute quietly its narrow sword-shaped strip of fluted green. Nothing, it seems there, of notable goodness or beauty. A very little strength, a very little tallness and a few delicate lines meeting in a point—not a perfect point, either—but blunt and unfinished, by no neams a creditable or apparently much-cared-for example of Nature's workmanship; made as it seems only to be trodden on today and tomorrow to be cast into the oven; and a little pale and hollow stalk, feeble and flaccid, leading down to the dull brown fibres of roots. And yet think of it well, and judge whether of all the gorgeous flowers that beam in summer air and of strong and goodly trees, pleasant to the eyes or good for food—stately palm and pine, strong ash and oak, scented citron, burdened vine—there be any by man so deeply loved, by God so highly graced as that narrow point of feeble green.

Observe, the peculiar characters of the grass, which adapt it especially for the service of man, are its apparent humility and cheerfulness. Its humility, in that it seems created only for the lowest service—appointed to be trodden on and fed upon. Its cheerfulness, in that it seems to exult under all kinds of violence and suffering. You roll it and it is stronger the next day; you mow it and it multiplies its shoots as if it were grateful; you tread upon it and it only sends up richer perfume. Spring comes and it rejoices with all the earth—glowing with variegated flame of flowers, waving in soft depth of fruitful strength. Winter comes, and though it will not mock its fellow plants by growing then, it will not pine and moan and turn leafless or colourless as they. It is always green; and is only the brighter and gayer for hoar frost.

NEW PUBLICATION

"THE STORY OF CANADIAN WHEAT"—Dr. E. S. Archibald. (Published by the Canterbury Agricultural College Old Students' Association).

This, the second Hilgendorf Memorial Lecture, was delivered by Dr. Archibald, Director of the Experimental Farms Service of Canada, during the Pacific Science Congress at Christchurch, February, 1949. Copies are obtainable from the Editor of this bulletin, price one shilling, post free.