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Water erosion control

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THE SOIL ... OUR BASIC ASSET

WATER EROSION CONTROL—I

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ALTHOUGH soil erosion caused by water action is common in our agricultural areas, effective control measures, likely to pay for themselves quickly, can be applied in nearly every case. Plant cover above the soil surface, and fertile soil with good structure are the main factors which enable soils to resist erosion. Dense pasture gives the best cover and at the same time improves the fertility and structure of the soil both effectively and economically, so land management adjusted to the need and capability of soils, slopes, and climate is of first importance. Contour practices are of secondary value and are used where needed to support suitable farming methods, thus the care of the soil is essentially in the hands of the farmer.

The sloping lands of the jam country from Northampton to Gnowangerup have suffered badly and nearly every paddock which has been observed shows some evidence of erosion. While the areas receiving from 15 to 25 inches of rain a year have suffered most, some water erosion has occurred in the drier country right out to the 11-inch rainfall line, and the wetter areas have also been damaged. Very little of this land has been in use either for extensive grazing or for agriculture for more than 100 years, and most of it has only been cleared and cultivated within the last 40 years. In this short space of time our farmlands have probably suffered as extensively and as severely as the rather older agricultural lands of New South Wales, Victoria and South Australia.

For five years our winter rainfall has tended to be lighter than average in the areas most damaged by water erosion, and summer rainstorms have been relatively few. Although damage has extended on some areas previously eroded, partial healing has often taken place. This has been greatly helped by the rapid establishment of large areas of improved subterranean clover pastures in this period. The areas on which erosion has continued to extend are considerable, and unless controlled will constitute a challenge to the ability of their owners to continue farming them profitably. Erosion control will become uneconomic on such land unless it is applied promptly, and most of the areas on which partial healing has occurred require further attention if they are to remain safe. Above all, the management of land not yet obviously damaged must be adjusted to reduce the erosion risk as far as possible. **In the agricultural areas, water erosion has caused many times more damage than wind erosion.**

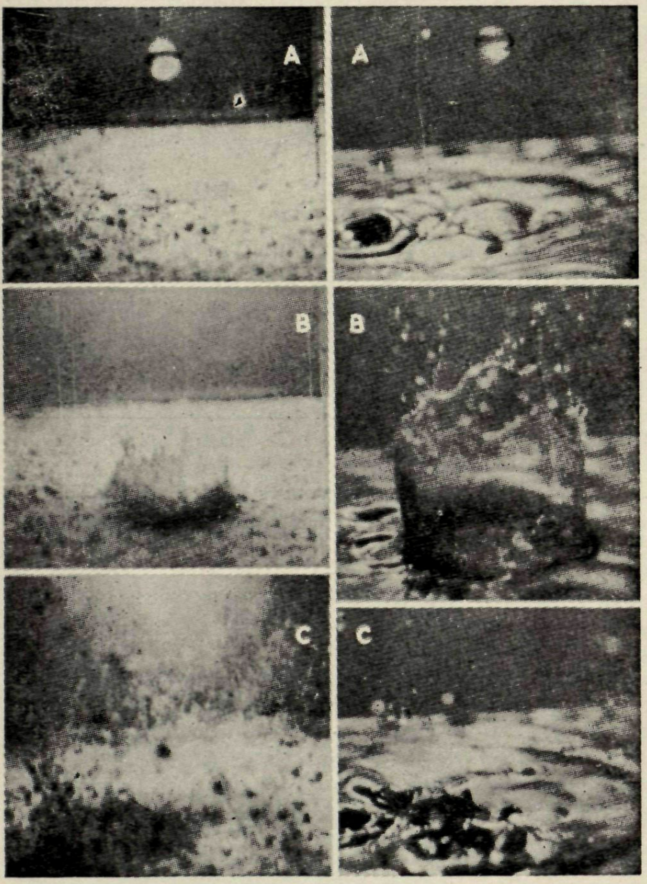

Fig. 1.—These high-speed photographs show the effect of raindrops in causing soil movement. The left-hand series shows a drop of water falling on loose powdery soil. A—Just before striking. B—Just after striking. The effect is that of a small aerial bomb. C—Four-hundredths of a second later, the air is filled with flying soil particles.

The right-hand series shows a drop of water falling on soil that is covered with a thin film of water. A—Just before striking. B—Just after striking, the water rises in the form of a cylinder. C—The cylinder collapses, leaving a turbulent wake which carried particles of soil away from their original positions.

(Photography by Edgerton, Germeshausen and Grier from "Agricultural Engineering.")

HOW DOES WATER EROSION TAKE PLACE?

Raindrop Pounding.—If rain is watched, it will be seen that each drop hits the soil surface and throws up a splash like a small bomb exploding. (See Fig. 1.) Recent investigations have shown that raindrop pounding of bare soil does two things:—

(1) It causes soil movement by raindrop splash.

(2) It slows up water absorption by the soil, either by the formation of a dense surface skin or of a pasty mass of soil and water.

On flat lands, these effects do not result in water erosion, but on sloping lands, the splash falls mostly downhill. Up to 75 per cent. of the splash falls downhill on a 10 per cent. slope. As the splash contains up to 40 per cent. of soil, raindrop pounding alone, without running water, can cause soil erosion on slopes. (See Fig. 2.)

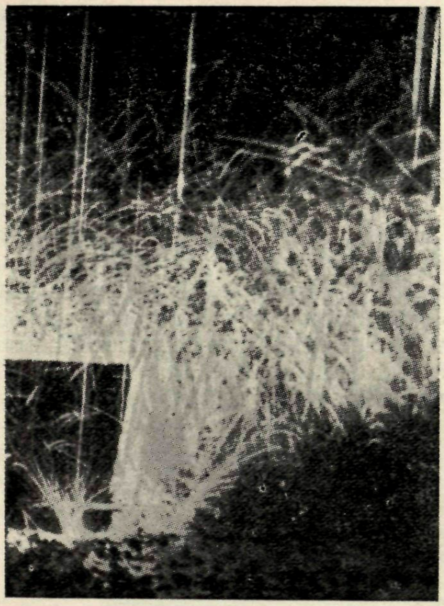

Fig. 2.—Rain falling on soil. The straight, almost vertical lines, indicate the paths of the raindrops. The mass of curves shows soil and water particles which splash from the soil surface as a result of the impact. (From "Agricultural Engineering.")

Sloping Soil and Running Water.—The surface sealing effect of raindrop action on bare soil causes much more runoff during any rains heavy enough to exceed the slower absorption capacity. Water running off sloping land carries soil particles thrown up by raindrop splash, and moves in a shallow sheet carrying a thin layer of soil. This is known as **sheet erosion,** and is very hard to detect. It is frequently the most serious form of erosion and may continue unobserved until most of the top soil has been carried away.

Running Water Tends to Concentrate and Cut.—As water moves downhill it tends to concentrate in hollows and cut small grooves known as **rills,** or deep trenches known as **gullies.** Trenches about 18 inches wide and 10 to 12 inches deep or bigger, are usually called gullies.

This knowledge of the ways in which soil erosion by water action takes place, gives a sound basis for the development of methods for controlling existing erosion and for preventing future erosion.

HOW TO CONTROL WATER EROSION

Main Needs are Surface Cover and Soil Fertility.—Investigation has shown that cover above the surface protects the soil against the bombardment by raindrops. A sufficiently dense cover prevents the raindrops from throwing up any soil in the splash as the force of all the drops is absorbed by the cover, and not by the protected soil underneath. The soil is also saved from the formation of a surface sealing skin, and can continue to absorb water at undimished rates. In addition to absorbing water more quickly while rain is falling, the soil is also able to absorb water up to the limit of its capacity to hold it. In contrast when the sealing effect is present to a very high degree, dry soil has been found two inches below the surface after heavy rains. In addition, when rainfall intensity exceeds the maximum absorption rate of the soil, the presence of cover on the soil surface greatly slows up the rate of moving water during the run-off which must then take place.

Surface Cover.—On farm lands, surface cover is most economically provided by crops or pastures. The efficiency of plant cover in giving soil protection, depends on the density of the stand and the amount of soil left uncovered.

Living plants use great quantities of water during growth, mostly between 300 and 1,000 times the weight of the dry matter formed in the plant. If there is any tendency to excess water in the soil, living plants are desirable. But obviously cover is effective whether plants are alive or dead, **as its principal functions are to absorb the force of the falling raindrops before they hit the soil surface, and to slow up the rate of moving water when run-off occurs.**

The most efficient plant cover is provided by plants which grow densely, near the soil surface. Good pastures

give a dense cover near the soil and so provide the most efficient cover on cleared land, providing grazing practices always leave enough cover. to protect the soil.

This underlines the need for a different outlook when gauging carrying capacity. Some of the most serious water erosion has occurred on overgrazed pasture lands. In the long run, it is likely to be more profitable to leave some pasture to protect the soil, because when topsoil is lost, production and income decline; and when most of the topsoil is lost, productive capacity is usually impaired for a long time.

Soil Fertility. — Investigations have shown that fertile soils resist erosion best. The need to maintain and improve fertility then, is important to help protect the soil from erosion.

Dense Pastures Cover Soil and Build up Fertility.—Improved pastures whether green or dry, best meet the need

Fig. 3.—Gully erosion has already made part of this wheatbelt paddock unfit for cultivation. Some of the gullies obviously follow old cultivation lines straight downhill. The gully on the right is extending uphill and unless adequate control measures are taken the whole paddock will become uncultivable. Improved pasture would probably arrest further erosion until parts of the paddock could perhaps be protected for safe cultivation by contour banks.

—Airphoto: Kingsley Watson.

for dense cover close to the ground, providing they are not overgrazed. Legume establishment is needed to improve our pastures. Legumes such as clovers and trefoils are especially valuable for grazing on account of their high protein content, and for soil improvement because the bacteria in their root nodules are able to fix nitrogen from the air. This eventually enriches the soil when the plant is grazed or dies. Organic matter is continually added to the soil dur-

more difficult as it needs rather more rain than for similar soils in the Central and Southern areas. The establishment of good stands of clover calls for longer pasture periods than has been the rule in wheatbelt rotations, and its introduction usually means adjusting the farm rotation by cropping smaller areas. Stock numbers should not be increased too rapidly, otherwise the clover will be eaten out before it has had sufficient opportunity to become established.

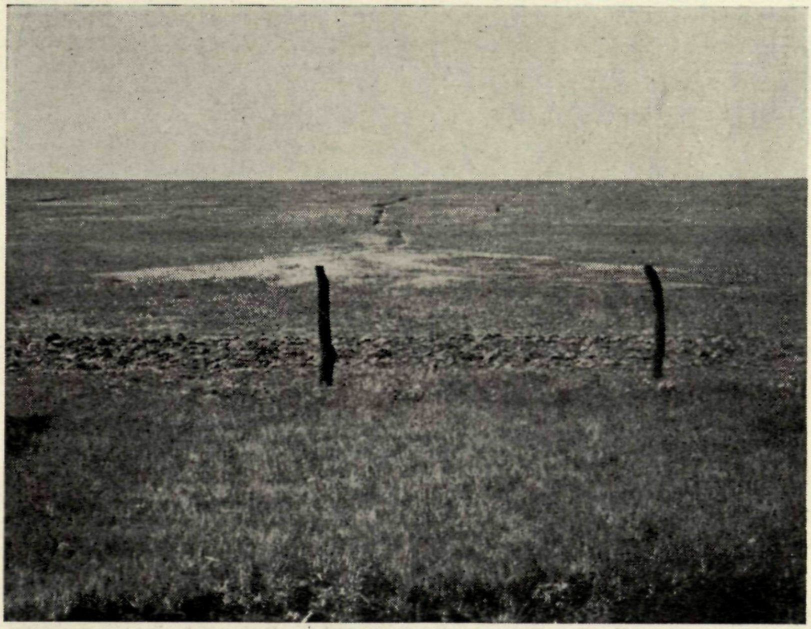

Fig. 4.—Erosion deposits in the Northam district. The lighter area above the fence posts is a deposit of soil and subsoil from the small gully above it. This gully is hardly bigger than a large rill.
Photo—Govt. Printer.

ing a period of good pasture and soil structure is greatly improved.

Subterranean Clover Improves Pastures.—Subterranean clover is by far the most valuable legume for improving pastures in south-western Australia. It grows well on practically all soils where there is enough rain, and on most soils of medium and light texture in the 15-25 inch rainfall zone. North of Coorow and Latham its establishment is

Crop Rotations.—The practice of crop rotation developed from the need to maintain and improve soil fertility and production and to spread labour. In future the suitability of any rotation to a particular area will be measured by the success of the rotation in fulfilling these needs while at the same time preventing soil erosion.

Periods of pasture are desirable on all soils and in all types of mixed farming. **Numerous experiments and the ex-**

perience of farmers generally, in Australia and overseas, have shown that the most effective and economical method of improving soil fertility is by the inclusion of a pasture period in the rotation. (See Figs 5 and 6.)

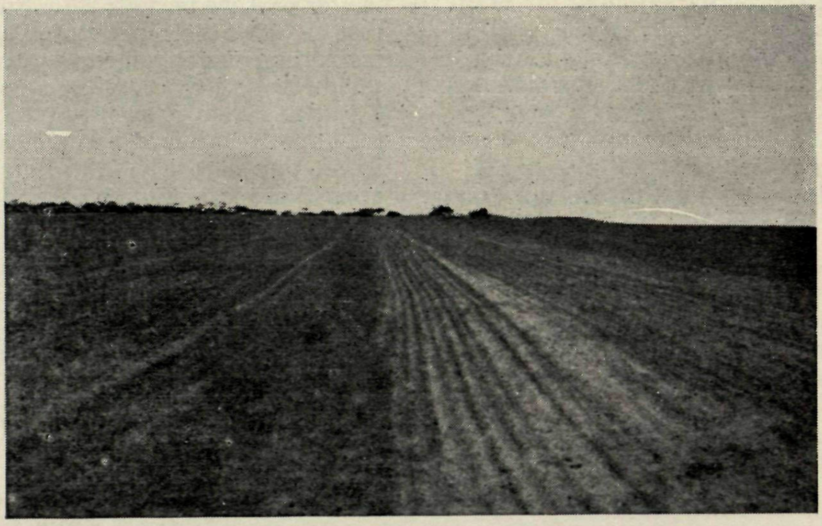

Fig. 5.—Light land at Wongan Hills sown to clover 1941, except the light coloured strip. The clover was ploughed and seeded to wheat in autumn 1947, and yielded better than 30 bushels an acre. In 1948 wheat was again seeded. Note better crop and darker soil where five years of clover pasture has added organic matter to the soil. Photo taken on 23rd June, 1948.

—Photo G. H. Burvill.

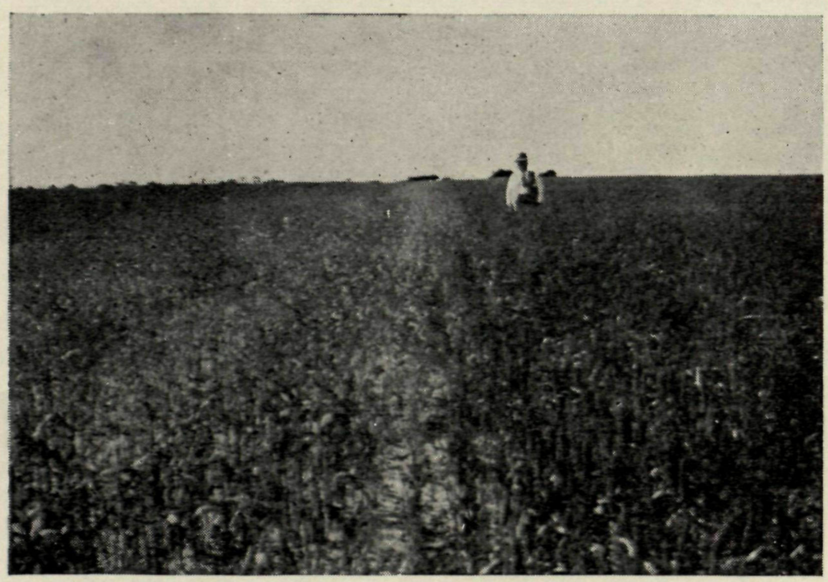

Fig. 6.—Photo taken October, 1948, on same strip as in A, but on the other side. Estimated wheat crop on old clover land at right, 21 bushels, and where clover not seeded, seven bushels an acre. This land was also under wheat in 1947.

—Photo G. H. Burvill.

Clover often takes from three to five years to become firmly established, but the adoption of heavy rates of seeding (up to 10 to 20 lb. per acre) by farmers who are gathering their own seed, has given good stands in one year. Naturally, the development of good stands takes longer on soils exhausted of fertility by overcropping or erosion.

Clover Disease.—There have been difficulties associated with the breeding of sheep grazed on pastures dominated by the Dwalganup strain of subterranean clover used in the wheatbelt. The Department of Agriculture has continued to advise farmers to keep on planting more Dwalganup clover because of its outstanding value in building soil fertility resulting in higher yields. (See Figs. 5 and 6.) Slower-maturing varieties such as Yarloop, Bacchus Marsh and Midseason (Mt. Barker), are grown in districts with longer growing seasons and more rain. The sheep breeding difficulties have been largely overcome by providing winter grazing of true grasses and cereals instead of nearly pure clover pastures.

Other Legumes Needed.—Clover does not meet all needs for increased carrying capacity and soil protection and improvement in these areas. The Western Australian blue lupin is also a valuable legume for these purposes. Barrel clover and burr trefoil are useful where they do well, mostly on soils of medium and heavy texture. Peas are grown to a minor extent. The search for other legumes is proceding actively and a vetch *(Vicia eurillia)* now named Malta, has given promising results on the Departmental Research Stations. As legumes respond particularly to phosphorus, continued topdressing with phosphates greatly encourages the legume plants in pastures.

Subterranean Clover Pre-eminent for Soil Conservation.—But subterranean clover is more adaptable to most situations than these other legumes. Perhaps the most important immediate aim of the Soil Conservation Service is to encourage the establishment of clover wherever soil and climate permit.

Surface Cover on Very Poor Soils.—Cereal rye is useful for establishing cover on areas where other crops and pastures have failed as it will make moderate growth on exhausted, deficient and eroded soils. It has made good cover on steep eroded slopes and is likely to assist establishment of subterranean clover or lupins in such cases. Seeding at 30 to 50 lb. with superphosphate at 80 to 100 lb. an acre is recommended for cereal rye.

DEEPER ROOTING PLANTS FOR SOIL CONSERVATION

Sub clover and ryegrass are rather shallow rooted plants while cereals are deep-rooted where soil conditions permit. Deep-rooting plants in our pastures could perform valuable functions particularly in the wetter areas where cereals are used less frequently in the rotation. After surface and subsoil drainage has taken place, water held in the soil is used for plant growth or is lost by evaporation. Excepting soils which crack deeply as they dry, little soil moisture is evaporated from deeper than two or three feet below the surface. **Use by plant roots is the only way of removing water held in the soil after drainage and evaporation have removed all they can. Deep-rooting plants serve to dry out the soil, partially or fully, to a greater depth.** This has several valuable results:—

(1) The soil can absorb more of the total rain which falls on it, with a consequent decrease in run-off. This reduces the erosion hazard.

(2) The soil reserves of soil moisture available for plant growth are increased if roots can reach them, giving the possibility of greater production and a longer growing season.

(3) The feeding area of plant roots is increased. This also gives the possibility of greater production and in pasture plants, has a value in concentrating plant nutrients from the deeper soil layers in the topsoil where most plant roots normally develop.

Working the Land*.—Fallowing as practiced in Western Australia leaves the soil bare for many months and greatly increases the erosion hazard on sloping lands. A rough, cloddy surface absorbs water better and resists erosion better than a fine mulch. Soils on which good subterranean clover pastures grow, will in most cases produce cereal crops without a period of bare fallow. Many sloping lands will need contour working on contour banks if they are to be fallowed safely.

ADJUST LAND MANAGEMENT FIRST

The following practices comprise a logical and economic programme for controlling and preventing soil erosion by water action:—

(1) The use of legumes, mainly sub-clover, for improving pastures.

(2) The use of improved pastures to cover the soil and improve its fertility and structure.

(3) The adjustment of grazing to always maintain better plant cover.

(4) Longer rotation to include several years improved pasture between arable crops.

(5) Avoiding bare fallow wherever possible.

(6) Reducing cultivation to the minimum necessary to kill most weeds and prepare a seed bed. This will leave the surface as rough and cloddy as possible consistent with these purposes.

(7) Use of the new weedicides will further reduce the need for cultivation.

These practices develop and maintain a dense plant cover for the longest possible period in rotations. They make and keep the soil surface more absorptive so that it lets rainwater in more quickly and there is less run-off. They make soil erosion less likely when run-off does occur and they maintain fertility.

All these practices can be put into effect by the farmer—in fact they are an integral part of sound farming technique, and serve to emphasise the statement made earlier in this article that "the care of the soil is essentially in the hands of the farmer."

In the next issue of the Journal it is proposed to discuss the use of contour practices as an aid to the basic control measures outlined above.

* See G. H. Burvill, "Changing Ideas in Soil Conservation," "Journal of Department of Agriculture, W.A.," Vol. 22, March, 1945, pp. 3-10, reprinted as Leaflet 809.

RIFLE AMMUNITION

THE Minister for Agriculture (Sir Charles Latham) recently discussed the question of supplies of 0.303 and 0.310 ammunition with the Federal Minister for Supply as the Agriculture Protection Board is anxious that farmers should obtain adequate supplies of ammunition for the control of vermin.

It was stated that all military stocks of 0.310 ammunition have been distributed and that all available 0.303 ammunition is urgently required for defence purposes. No more ammunition of these types can be released at present but arrangements are being made for the importation of supplies of both types from England.