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Manufacturers of
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Rotary Hoes Ltd.

HOWARD
ROTAVATOR

ROTAVATION

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CONTENTS

This account of Rotavation is not only based on long practical experience and on sound farming theory but on authoritative scientific findings and recent investigations at various Universities and Agricultural Colleges. Among these, seed bed preparation and germination in rotavated seed beds was studied by Merridew, while Machinery Lecturer at Wye College, London University. He also published results in "Rotavator Pictorial" on work which he carried out on re-seeding pastures and leys and for production of catch crops.

Land Reclamation was undertaken by Gordon Newman, when working at the University of Wales, near Aberystwyth. He also published articles in "Power Farmer" on the application of the Rotavator based on his own farming experiences.

Recently, Fail of Durham University published a paper on weed control in "The Journal of Agricultural Engineering". The results of his work on this subject proved that the Rotavator would eliminate couch and twitch and also control bracken.

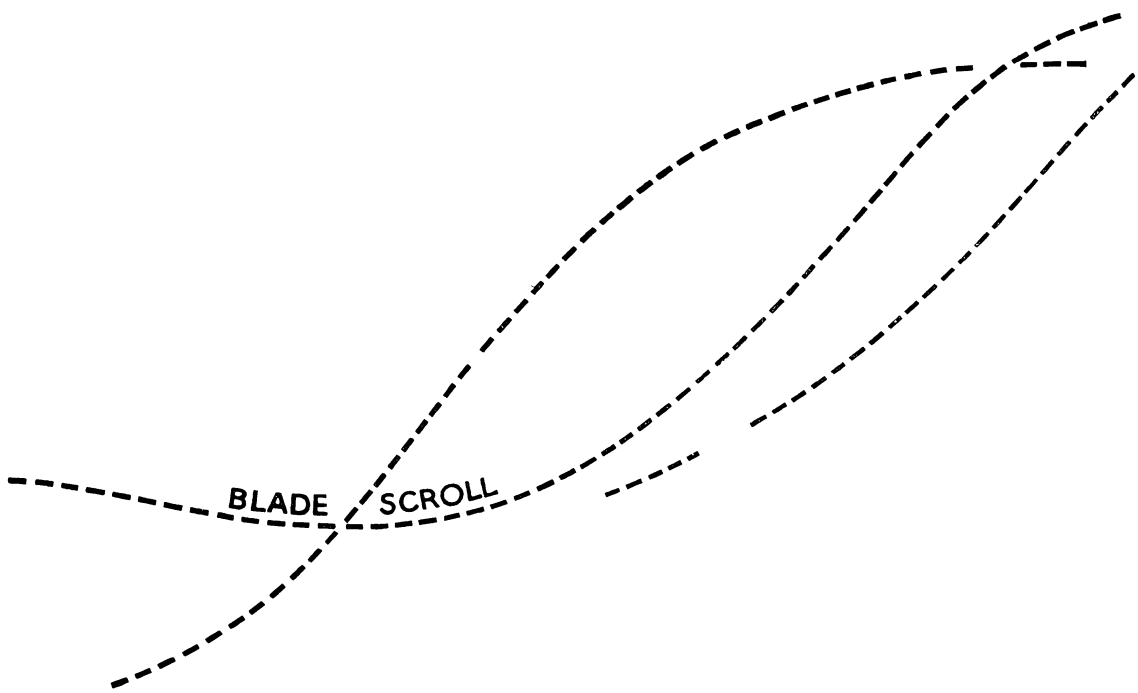
Various methods of mixing materials with the soil to control soil borne diseases have been studied by Dr. Grainger at the West of Scotland Agricultural College and also at the U.S. Department of Agricultural Machinery Research Station, Beltsville. The results showed that Rotavation gave real and thorough mixing, which had not been achieved by other methods.

The Forestry Commission have allowed the publication of Rotavation trials conducted by them.

Recent work carried out by the Coffee Research Station at Ruiru, Kenya, also stressed the practical applications of Rotavation in crop production.

Growers reports in general show, too, that Rotavation has been successfully used for a wide range of crops in many climates and on many soil types. Market gardeners, nurserymen, fruit growers and private gardeners have been quick to appreciate the advantages which it gives. In fact, Rotavation has been accepted in countries all over the world.

These notes are based largely on the British system of farming. They clearly outline the principles involved, so that farmers and gardeners everywhere, whether on a large or a small scale, will know how best to apply Rotavation to their particular crops on all soils and under different climatic conditions.


BLADE
SCROLL

Rotavation is the direct application of engine power, either from the tractor on farming models or from a suitable power unit on self-propelled machines, through a rotor and hoe blades of special design to the soil.

All the main principles of cultivation are covered by this method and all cultivations are ultimately concerned with the creation of tilth and seed beds. Thus, the working of the soil by Rotavation also gives control over weeds.

Rotavation can take place at any season of the year when the soil is suitable for working. It has a wide range of applications to other work on farms and gardens besides straightforward cultivations and many of these uses appeal to other trades.

Apart from such specialised uses, Rotavation rests on six principle applications—

(**1**) as a means of cultivation for the production of tilth for seed beds, both on light and heavy soils

(**2**) as a means of controlling weeds

(**3**) for breaking up permanent or temporary grassland

(**4**) for mixing crop residues, fertilisers or manure with the soil and in trash farming and horticulture

(**5**) for the quick establishment of catch crops, and permanent or temporary grasses

(**6**) for reclamation of scrub, waste land and in forestry.

A section of this booklet is devoted to each of these applications and in addition the final sections illustrate and explain many other uses to which Rotavation has been put in practice.

what it does and how it does it

The use of Rotavation requires a working understanding of the main principles, so that the operator may obtain the result he desires. Farmers and others well know that the actual tilth, coarse or fine, according to season and purpose, must be varied, especially on heavy land. On the easier-working light lands, this is of relatively little importance. The variety of soil types even on a single farm may be considerable and the practical man in all his operations is familiar with these variations. The farmer has been accustomed to weigh up what sequence of implements he will have to use to get the result he wants. He will, when using Rotavation, consider the four factors which follow, two of which are inherent in the machine and two inherent in his soils. These, properly applied, can lead to fewer individual operations to achieve his purpose.

(1) The type of soil—heavy or light

The amount of clay in light soils is insufficient to make such soils form clods and they are therefore inclined to disintegrate with any form of tillage. Care should be taken when Rotavating these soils to work at the highest ground speed practicable, so that the soil is left as coarse as possible.

Special blades exist for tropical conditions where a coarse finish is an important factor for controlling water supply to the crop.

(2) The moisture content of the soil

There is a certain range of moisture content which the farmer recognises when a particular soil is in a condition most suitable for cultivation operations. Due to their clay content some soils tend to ' ball ' and fail to produce a tilth if Rotavation is given when the moisture content is too high. Conversely, if such soils are too dry then dust as well as agregates are produced. Generally speaking, satisfactory results can be produced under slightly wetter conditions than those suitable for ploughing.

Light soils should, whenever possible, be worked before drying out.

(1) Speed of travel

This can be varied in relation to the speed of the Rotor, which is fixed by the size of drive sprocket used thus, the size of the slice of soil cut by the hoe blades can be changed.
The lower the travel speed the finer the tilth will be, for there are more cuts by the blades per foot of travel. Conversely, the faster travel speed the fewer the cuts made by the blades per foot of travel —the result is a coarser tilth.

This is true of both heavy and light soils, although the very light soils will in any case break down to a finer tilth and, in consequence, can normally be worked at a higher travel speed to obtain a tilth. The relative rotor speed can be altered by changing the driving sprocket where necessary to suit the travel speed and the nature of the soil in order to produce the desired tilth.

(2) The position of the Rear Shield

The soil cut by the blades is lifted and is broken by impact on the shield, mixing taking place at the same time. This occurs both on the front fixed part of the shield and also on the hinged rear portion. When the hinged rear portion is raised, a coarser tilth is obtained; conversely, with the shield in the lowered position a finer finish is produced.

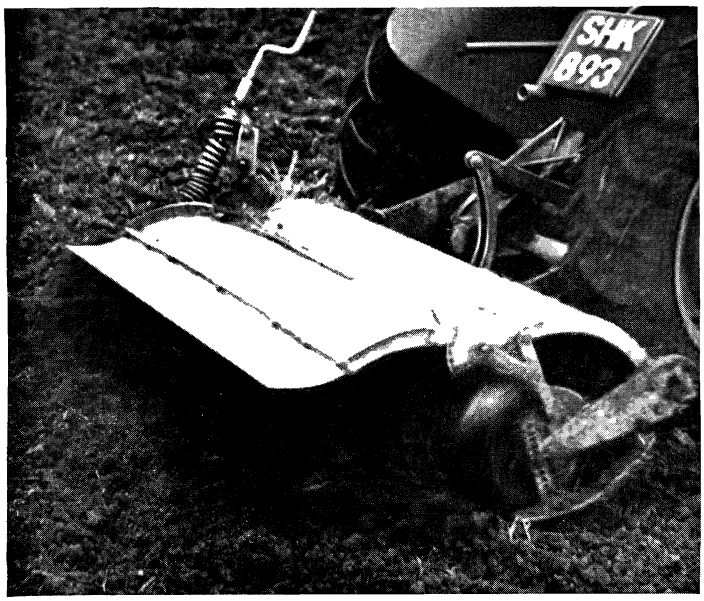
Within, therefore, these four factors a wide range of work with variable finishes can be obtained. Each factor affects the other to a greater or lesser degree.

on heavy land

" . . . a smooth surface would obviously give a maximum exposure to wind whereas a rough surface with sizeable clods provides a considerable amount of shelter."

—SIR JAMES SCOTT WATSON AND JAMES MORE IN " AGRICULTURE," 9TH EDITION. (OLIVER AND BOYD)

To prevent Autumn seed beds on heavy land becoming water-logged by the winter rainfall it is generally recognised that a rough tilth is necessary.
To obtain this rough finish, work should be at as high a travel speed as is possible for the depth of cultivation desired. This should preferably be between four and six inches.
The rear shield of the Rotavator should be raised.



" . . . deep ploughing naturally increases the permeability of the ploughed soil and the goodness of its aeration, and hence allows the soil to drain quicker provided the deeper sub-soil is permeable or has an efficient drainage."

—SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

The preparation of a seed bed on heavy land for the Spring sowing commences in the preceding Autumn.

The production of tilth for the Spring seed bed is greatly helped by frost action during a normal winter. Frost action on the maximum amount of soil is obtained when the land is left rough. Where the Rotavator alone is used, the land should be rotavated at high travel speed with the rear shield raised, which will give a rough finish. The tilth produced by the frost during the winter will be confined to the top few inches of soil. In the Spring the weathered soil should be again rotavated, this time to shallow depth.

When, however, Rotavation is employed in the Autumn for cleaning the land or where the depth is insufficient or the finish deemed to be too fine, ploughing on farmland should then be done—the finer tilth created at this time is then put under the soil and protected by the rough clods created by ploughing. In domestic or kitchen gardens, or where ploughing is not practicable for this purpose, the soil should be ridged up. All the smaller hand-controlled Rotavators can be fitted with ridging attachment, allowing the work to be done at the same time as the rotavating.

" It is a general rule that the size of the seed bed crumb must be related to the size of the seed . . . the drier the soil in the zone of the seed the more firmly must the seed bed be compressed."

—SIR JAMES SCOTT WATSON AND JAMES MORE IN " AGRICULTURE," 9TH EDITION. (OLIVER AND BOYD)

In the Spring, the weathered soil on farm or garden should be rotavated to a shallow depth to provide a seed bed. As the surface soil in the Spring is normally friable, the travel speed can be high but, since a fine finish is wanted, the rear shield should be in the lowered position.
If a second Rotavation is given to obtain the desired finish, it should be at shallower depth than the first pass, especially where between rotavations weeds have germinated, thus cleaning the final seed bed.

" The Rotary cultivator was preferable for soils not in good condition as is the case after a wet and open Winter."

—J. MERRIDEW, M.SC., WHEN MACHINERY OFFICER AT LONDON UNIVERSITY, WYE COLLEGE, KENT, WRITING IN "FARM," NO. VI. VOL. II.

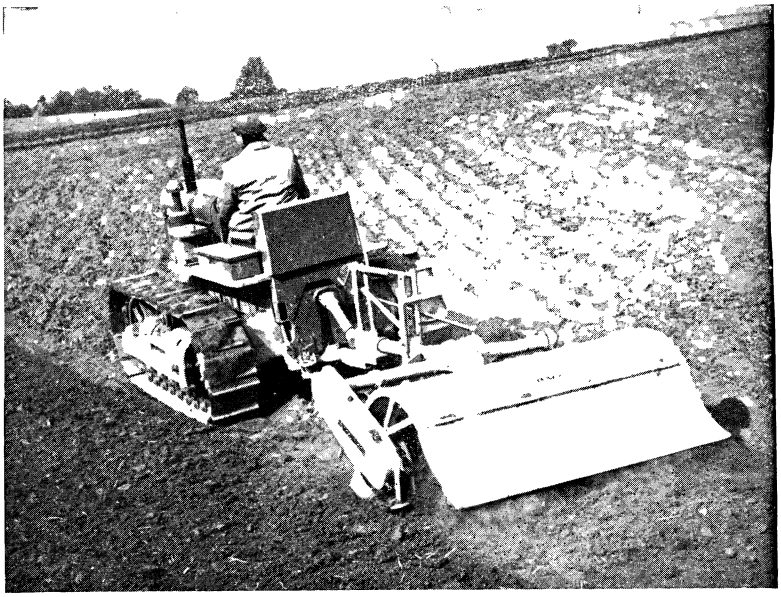
Where in the Spring little or no weathering has occurred and the land lies rough with a danger of it baking out, a forced tilth can be obtained by Rotavation.
This operation must be carefully timed. It must be done before the soil dries out too much into hard intractable clods. Two or more passes may be needed, according to the accuracy of the timing. Since Rotavation can be done under rather wetter conditions than normal cultivations, the time available is greater before complete baking out can take place.

on light land

The free drainage properties of light land allow the preparation of Autumn seed beds over a longer period. If the land varies from field to field, it is normal practice on farms to cultivate the heavier fields first. Indeed, cultivation on light land may be deferred until the turn of the year. Autumn seed beds for corn on such land need not be deeply worked and the Rotavator may be used at a high ground speed.

The preparation of the seed bed may be combined with cleaning the land and controlling the weeds.

When light land is cultivated in the early Autumn there is a danger that it may dry out too much for the establishment of catch crops sown at that time and the more cultivations given the greater the danger. Rotavation allows the preparation



of such seed beds with the minimum soil disturbance and the least number of operations. In consequence there is a minimum loss of moisture.

"In order to ensure a supply of moisture to the plants at the time in question the seed bed must be made firm and fairly fine."

—SIR JAMES SCOTT WATSON AND JAMES MORE IN "AGRICULTURE" 9TH EDITION (OLIVER AND BOYD)

To produce a tilth it is unnecessary to leave the lighter soils rough during the winter, all cultivations being carried out in the Spring. There is also little danger of producing one which is too coarse for a seed bed.

Travel speed may be high and the Rotavator may be set for full depth. Two passes are generally sufficient to produce the seed bed. If the second Rotavation has a depth of two inches, it can be used to produce a weed-free seed bed.

It is important, especially under drying conditions, that the bed is consolidated so that the seed is in contact with moist soil. Rolling is done before sowing under dry conditions and where the top inch or two of soil has dried out. The seed drill is set to place the seed in moist soil below.

Where heavy rains fall on the freshly made seed bed or there is any tendency to cap, the cap can if necessary be broken by rolling with a Cambridge Ring Roller.

for control of weeds

BOTH ANNUAL AND PERENNIAL

There are three accepted ways of dealing with weeds. They may be dug or ploughed under; treated with selective herbicides (i.e., weed-killers); their seeds may be encouraged to germinate at a time when they are harmless to the crop and then duly destroyed. Weeds are of two main types, annual and perennial. The perennial types are the more difficult to eradicate.
Soil, climate and the type of farming determine which weeds become predominant. The methods of eradication and the best time to apply them are determined by the circumstances. The Rotavator may be used at any appropriate time.

"There is an increasing body of evidence which indicates that weeds are usually most harmful to the crop during early, and particularly the very early, stages of growth. Hence the importance of clean weed-free seed beds." —SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

Rotavation is used to encourage the germination of weed seeds and so promote a clean seed bed.
Usually, it is the weed seeds in the top two inches of soil which germinate and compete with the crop in its early stages. Having obtained a tilth by means of Rotavation, the weed seeds should be allowed to germinate. This normally takes from 10 to 14 days and experience suggests that it is not necessary for the weeds to show green. An examination of the soil will show whether the seed has germinated in the top two or three inches. When there is an abundance of white thread-like rootlets or shoots, the land should again be rotavated to a depth of not exceeding two inches. The weeds which have germinated in these top two inches will then be destroyed.
The final Rotavation given for the seed beds should not exceed the depth of these earlier Rotavations or ungerminated weed seeds may be mixed with the clean soil.
" . . . the percentage germination of seeds on rotary tilled plots is much higher than on ploughed plots and the initial growth is faster . . . " —J. MERRIDEW, M.SC., WHEN MACHINERY LECTURER AT LONDON UNIVERSITY, WYE COLLEGE, KENT, IN "FARM," NO. VI. VOL. II.

"Ill-drained clays require the most frequent fallows both because they quickly become foul and because opportunities for Spring and Autumn cultivations are very limited."
—SIR JAMES SCOTT WATSON AND JAMES MORE IN "AGRICULTURE," 9TH EDITION. (OLIVER AND BOYD)

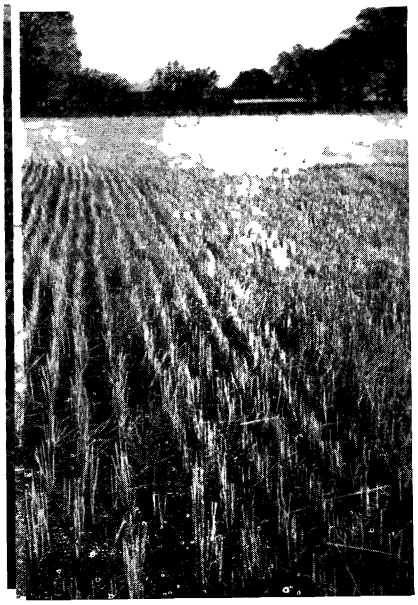
Where land has become heavily infested with weeds, both annual and perennial, a full or part fallow may become necessary. Rotavation which makes an exceptionally well aerated seed bed provides the best conditions for the germination of weed seeds.

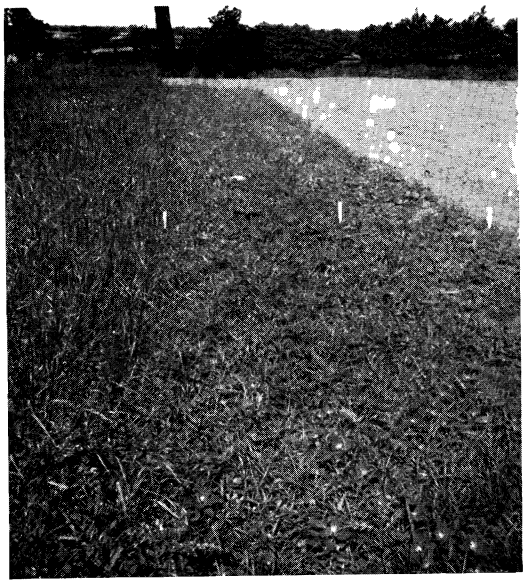
Thus, in the full Summer fallow a number of Rotavations are given whenever the weed seedlings show green or when the worked soil is, on examination, seen to be full of rootlets and shoots.

The first pass should be shallow and the depth increased at each subsequent pass until the full working depth of the machine is reached. By these means, the weed seeds are germinated from each successive layer of soil and are destroyed in depth. At least three passes should be given to reach full depth.

" Experiments over four years at six centres . . . showed that wickens (couch and twitch) if cut into short lengths by the rotary cultivators working some six inches deep and stirred at intervals by further rotavations, were completely eradicated . . . on soil types ranging from wet coal measure clays . . . to dry loams on millstone grit formation."

—H. FAIL, B.SC., OF KINGS COLLEGE, DURHAM UNIVERSITY IN THE "JOURNAL OF AGRICULTURAL ENGINEERING RESEARCH," VOL. 1, NO. 1. 1956





These two weeds and their allied types are among the most prolific and noxious throughout the world. They have rhizomatous stems which travel through the soil sending up shoots as they go. Hitherto it has been believed that to cut up or break this stem only increased the spread of these types of weed. Fail has proved that where Rotavation is used, the cut stem dies back and the shoots become progressively weaker so that, by three to five Rotavations, couch and twitch can be eradicated.
While Fail's work was carried out during Summer fallows, others have had success by employing one or two Rotavations late in the year (before Christmas) followed by two more in the early months of the following year. This avoids the necessity of taking a full fallow and losing a crop.

(*Pteridium aquilinum*) also yields to Rotavation, Fail states in the paper quoted above. He has found that bracken can be eradicated on land which can be rotavated in stages to 10 inches deep, any time between July and December.
Alternatively, he has had success by rotavating to 6 inches deep in July, followed by a repeat to 6 inches deep in the July of the following year.
Spread of bracken can be prevented by what he describes as a 'bracken break', which is a rotavated strip around the infested area.

" The object . . . is to induce the germination of weed seeds that have been shed before or during harvest."

—SIR JAMES SCOTT WATSON AND JAMES MORE IN "AGRICULTURE" 9TH EDITION (OLIVER AND BOYD)

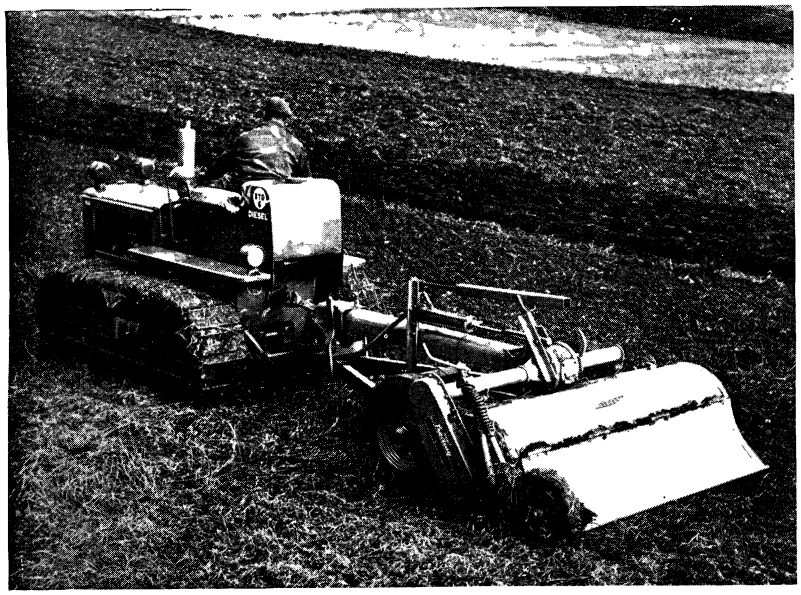
Where time allows, the opportunity should be taken to encourage the germination of many of the weed seeds which lie on the surface of the soil following harvest, before Autumn sowing or the main Winter cultivations. Shallow Rotavation as soon as possible after lifting or harvesting the crop will create a seed bed in which many weed seeds will germinate. These may be destroyed by further Rotavation and if time permits as many as three weed shoots may be taken. Every weed seed which can be germinated after harvest is one less weed to deal with in the future.

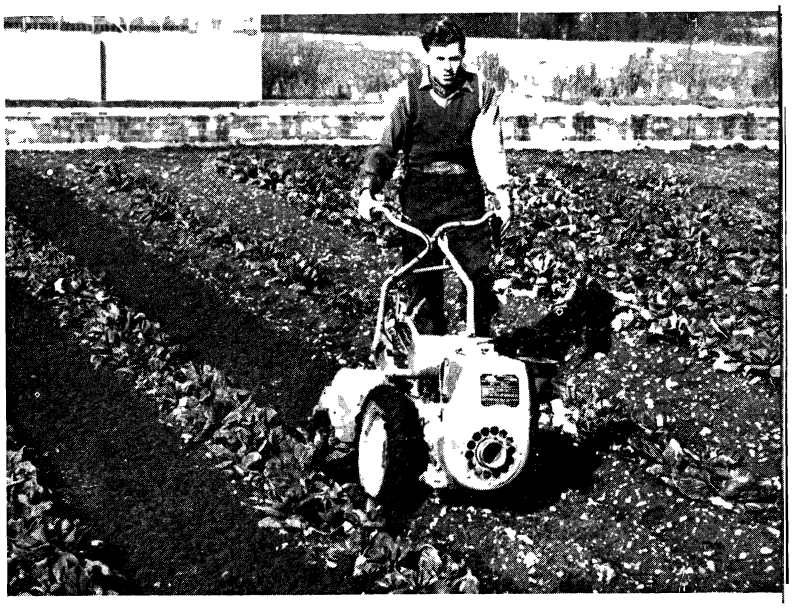
"These hoeings do two distinct things; they kill the weeds growing between the rows and they loosen the surface soil."

—SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

Rotavation may be used for inter-row cultivations, both with the larger tractor-drawn machines which are used in both tree fruit and bush fruit plantations and the smaller ones used for such crops as hops in this country and many plantation crops in the tropics.
The smaller machines are used in market and private gardens and are also employed on such field crops as sugar beet.

Deep cultivation should be avoided since there is a danger of damaging plant roots. Rotavation is given as required and a high travel speed may normally be employed.
The removal of some of the hoe blades on the rotor has made cross blocking possible with certain crops. In addition, for crops such as strawberries which are spaced in rows from 30-36 inches apart, removal of the central blades makes it possible to hoe up to two rows with a tractor drawn Rotavator





After field observations had been carried out by H. C. Pereira, Soil Physicist, East African Agriculture and Forestry Research Organisation (formerly the Coffee Research Station, Ruiru) and P. A. Jones, Agricultural Officer (Experiments) at Ruiru, they found at first that, for control of weeds and prevention of erosion, the native hand fork consistently gave better results than any other forms of cultivation. However, following trials with a Rotavator with specially designed rotor, results appreciably better than those obtained with a native hand fork were forthcoming.

The following tilth analysis is taken from the **Guide to the Research Laboratories and Field Experiments on Jacaranda Estate,** published by the Department of Agriculture, Kenya, for the Planters' Day, July, 1956.

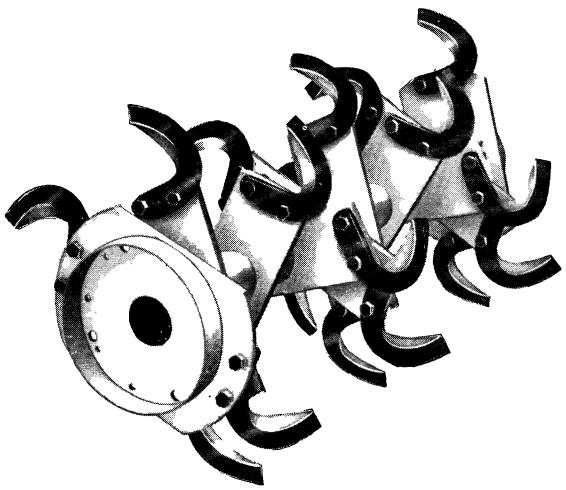
Implement	Large clods over $2\frac{1}{2}$" sieve %	Small clods over $\frac{1}{2}$" sieve %	Crumbs over $\frac{1}{2}$mm sieve %	Dust through $\frac{1}{2}$mm sieve %
Handfork	19·11	11·23	39·30	30·36
Modified rotary hoe	22·82	11·17	39·08	26·99

The principle here is to cut down weeds while leaving the soil in a cloddy condition which the heavy tropical rains cannot erode. It follows therefore that where similar soil conditions exist the special Coffee Rotavator will find applications in other crops.

for breaking pastures and leys

" . . . the ley must be regarded as the pivotal crop upon which to base our rotations. The Grass Legume Ley is a soil replenishing crop."

—DR. WILLIAM DAVIES, D.SC., HEAD OF THE GRASSLAND RESEARCH STATION IN " THE GRASS CROP, ITS DEVELOPMENT, USE AND MAINTENANCE." (SPON).



It is a well-known fact that land which has been down to grass for a number of years has an improved and more stable structure than similar land which has been under arable crops.

One of the objects of ley farming is to improve the soil structure for the arable part of the rotation.

The improvement in structure is closely associated with grass roots and is greater near the soil surface where these have had their greatest development.

The breaking of the ley or grassland is a most important operation. If they are broken too deeply by ploughing then the soil with the best structure is buried and the benefit to the arable portion of the rotation is reduced or delayed. The ley or grassland should be broken so that the soil with the best structure is retained near the surface and the organic matter accumulated during the ley in the soil is mixed with the soil to maintain structure as long as possible. Both these objects are best achieved by Rotavation.

" The aim is always to break up the turf prior to ploughing so that air and water can freely enter and penetrate into the root mat . . . nowhere more successful than on difficult Midland Clays."

—DR. WILLIAM DAVIES, D.SC., IN " THE GRASS CROP, ITS DEVELOPMENT, USE AND MAINTENANCE " (SPON)

The correct technique is a shallow Rotavation to break up the turf and mat and to allow an interval of from two to three weeks to kill the turf. Two further Rotavations are then given, when fertilisers or lime may where necessary be mixed with the soil to bring is up and make a mulch with the disintegrated turf. It has been shown that the turf-soil mulch gives a better seed bed and germination than that obtained where the turf is turned in by ploughing.

" Nothing does more good to rough grass than to tear it about during the Winter to break up the mat and aerate the surface soil."

—DR. WILLIAM DAVIES, D.SC., IN " THE GRASS CROP, ITS DEVELOPMENT, USE AND MAINTENANCE " (SPON)

Old pastures become very dense and matted. The grasses tend to degenerate and some of the desired species are inclined to die out. Conditions can be improved by Rotavation, using special rotors fitted with Pasture Renovating Tines.

These tines are specially shaped to penetrate straight into the soil, turn over with the rotor, shatter the soil and cut a gap through the turf mat as they rise to the surface.

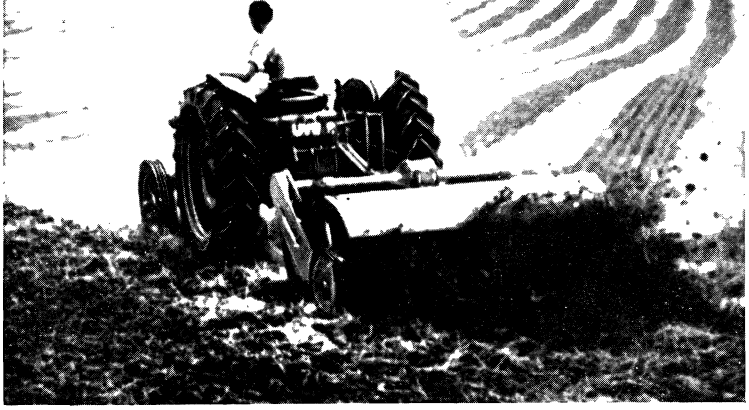
It is deliberately a rough operation and is carried out in late Autumn. In the Spring, the land should be rolled and heavy stocking is advised during the Summer.

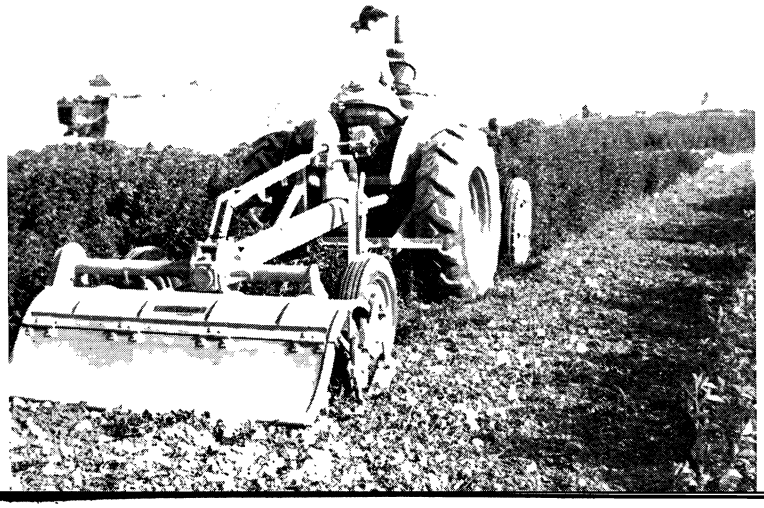
The pulling about and aeration re-enliven the turf and fresh growth quickly fills in the gaps which have been torn in the surface.

The possibility of establishing grasses first and legumes later in cuts made by the tines has been suggested.

In some countries, grass seed is broadcast over pastures which have been thus treated to replace some of the grasses which have died out or become depressed. Cattle are turned in early to consolidate the strips where this seeding is done.

It has been suggested therefore that the same technique could be used to increase or establish leguminous plants, such as clover, where a long dry period kills the legumes in the ley.





for mixing both organic and inorganic matter in the soil

" Any increase in the available organic matter capable of supplying energy at once increases the number of micro-organisms (i.e., Bacteria)."

—SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

Rotavation is the ideal method for incorporating many of the different organic and inorganic materials necessary for the maintenance of fertility in the soil.
A brief explanation of some of these, with a note on the methods to be employed, will suggest how the principle could be extended to other crop residues and materials.

The Chief Scientific Adviser to the Ministry of Agriculture, Prof. H. G. Sanders, speaking at a Soil Fertility Conference at Exeter, described the burning of straw as a 'farming crime' and said 'humus is the key to fertility and the incorporation of organic material in the soil is thus essential.'

—Reported in the "Farmers Weekly," Jan. 13th, 1956.

Ploughing in straw is not possible without modifications of normal equipment.
Where combine straw has not been baled, Rotavation will mix it in the soil so that on decomposition it produces humus. Ploughing, if then necessary, will be much easier.
If possible the straw spreader on the combine should be used in advance of the Rotavator so that the straw is evenly distributed over the area. The Rotavation of the straw should be done as soon after harvest as possible, before the land has fully dried out.
When a follow crop is to be sown immediately, a light dressing of nitrogenous fertiliser should be given to assist the decomposition of the straw.
Where the straw spreader has not been used behind the combine, Rotavation should take place diagonally across the windrows, as this evens out the distribution.

" Farmyard Manure is the best all-round soil improver . . . Not only does it supply to a greater or lesser extent all plant foods . . . but it improves the texture and tilth of the soil, increases its capacity to hold water and encourages the bio-chemical actions which are essential to plant life."

—SIR JAMES SCOTT WATSON AND JAMES MORL IN "AGRICULTURE, THE SCIENCE AND PRACTICE OF BRITISH FARMING," 9TH EDITION (OLIVER AND BOYD)

The value of dung has always been recognised. Apart from the manurial value, which varies considerably, the benefit to the soil is largely due to the humus which is thus added and to the effect which organic matter has on soil structure.
Rotavation mixes dung in evenly through the working depth of the soil and may be done at any convenient time after spreading.
Rotavation may also be used for spreading dung. The Rotavator is set so that the rotor blades just skim the surface of the land. The dung is put down in small heaps from the dung cart and the operation is carried out diagonally across the rows of heaps thus giving an even spread. A high ground speed can be used and the rear shield should be raised so that the dung is well spread over the land.

Among other factors, Sir John Russell, in "Soil Conditions and Plant Growth," 8th Edition (Longman), states:—
"The material should be in as fine a state of comminution (i.e., small particles) as possible."

Turning in crop residues to good account has hitherto presented difficulties.
Rotavation has put an end to this. Its cutting, shredding and mixing action makes it possible to work almost any crop residues into the soil.

In British farming it has become common practice to rotavate to dispose of crop residues such as brussels sprouts and other brassica as well as sugar beet tops which add fertility to the soil.
Abroad, such crops as sugar cane, maize stalks or pineapple plants are regularly worked into the soil to give increased humus.
In market gardening, where the land is more intensively and closely cropped, the residue of the one crop can be worked in while preparing the seed bed for the succeeding crop.
Some of this work borders on reclamation and Rotavation is commonly used to grub out small shrubs and bush fruit such as gooseberries, currants and strawberries.

"Green manuring can either increase the humus content of the soil or else the supply of nitrogen but rarely can it do both at the same time."

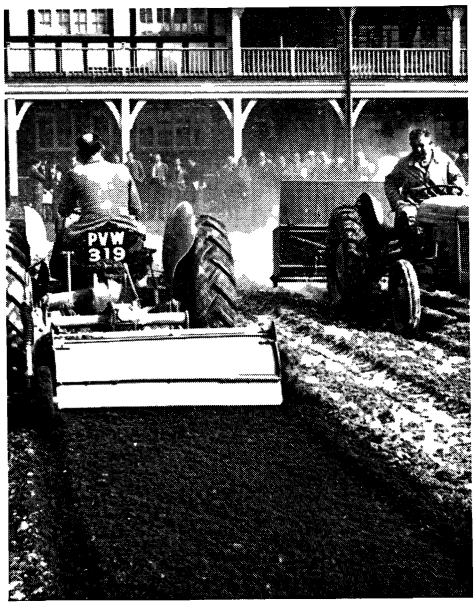
—SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

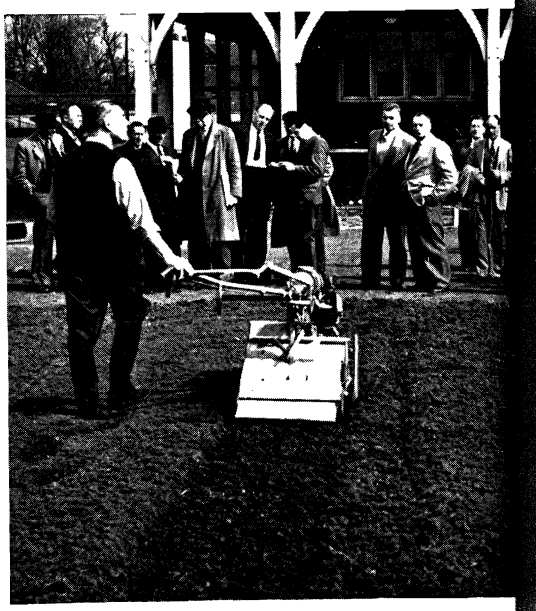
"Clearly the ideal to aim at is to have an even distribution (of lime) both horizontally and vertically through the soil."

—GARDNER AND GARNER IN "THE USE OF LIME IN BRITISH AGRICULTURE," (SPON)

While even horizontal distribution is readily secured by use of modern lime spreaders, only Rotavation can give adequate mixing vertically. Investigations both in this country and in America covering methods of distributing a powdered material throughout the soil has proved the efficiency of Rotavation.

In these trials, radioactive elements were used to trace the efficiency of the mix and reports may be found in "Agricultural Engineering" (Vol. 34, No. 10) which is the Journal of the American Society of Agricultural Engineers, and in "Nematologica," Vol. 1, No.1, by Dr. J. Grainger of the West of Scotland Agricultural College.





If the crop grown for green manuring is rotavated into the soil while young, then the leaf contains readily decomposed protein and the nitrogen which has been stored in the plant becomes available on decomposition. A green crop may therefore be sown to prevent leaching of nitrogen from the soil

When such a crop is allowed to mature, the material tends to be more resistant to decomposition and humus is finally formed. A green crop which has been sown with humus in mind must therefore be allowed to reach a more mature stage.

In market gardening, where following a glut a crop fails to sell, Rotavation makes it possible to turn such waste to good account. In certain parts of the world, 'trash' or 'mulch' farming and horticulture depend on the ability to mix green crops and plant residues with the soil.

The Rotavator is the accepted implement for this work.

"White mustard . . . is often grown after a crop of early potatoes and is useful for conserving the residues of the heavy dressing of manure applied to this crop."

—JAMES SCOTT WATSON AND JAMES MORE IN "AGRICULTURE THE SCIENCE AND PRACTICE OF BRITISH FARMING," 9TH EDITION (OLIVER AND BOYD)

Many other crops may also be used, some of which may be combined with providing stock feed during the late Autumn or early Spring.

"The problems of maintaining a stable soil structure usually only concern the surface soil . . ."

SIR JOHN RUSSELL, D.SC., F.R.S., IN "SOIL CONDITIONS AND PLANT GROWTH," 8TH EDITION (LONGMAN)

Gypsum and certain synthetic soil conditions are now being used for the improvement of soil structure. This is particularly important on heavy lands.

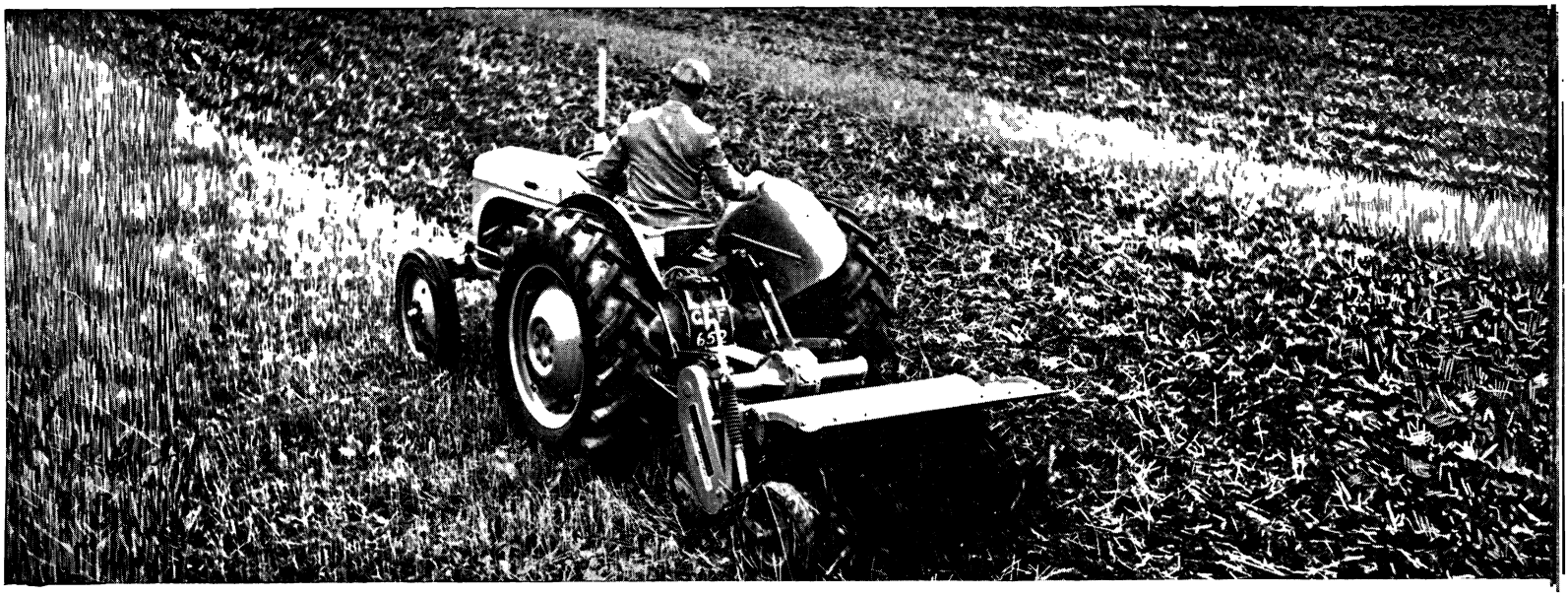
The success of these materials, as with lime, depends on efficient horizontal and vertical mixing and it follows that Rotavation is the means by which this may be done.

In the laying of sports grounds and other sites where levels have to be corrected by cutting and filling, Dr. McKenzie Taylor has proposed that before the surface soil is replaced, the areas which have been levelled should be treated with the material (gypsum) and, when it comes to a tillable condition, mixed in with the sub-soil by using the Rotavator. The top soil is then returned and a similar treatment repeated. This recreates the soil structure destroyed by the heavy equipment used and re-establishes the natural drainage of the soil.

for establishing forage and catch crops

"The ley must be sown without
a cover crop and grazed from the outset."

—DR. W. DAVIES, D.SC., IN "THE GRASS CROP, ITS DEVELOPMENT USE AND MAINTENANCE" (SPON)



At Wye College, Kent, Professor Cooper and Mr. A. G. Davies developed the practice of direct Autumn sowing in place of undersowing the cereal crop, despite the fact that Kent is one of the drier areas of Britain in Autumn.
Modern short-strawed and heavy-cropping cereals can prevent the expensive grass seeds taking well. In addition, when they do, the grasses can interfere with the harvesting of the cereal crop, especially in a wet year.

i.e., Permanent or Temporary Grassland after Harvest.
". . . in preparation for the ley, the aim is to produce a fine surface tilth with the ground fully consolidated . . ."
—DR. W. DAVIES, D.SC., IN "THE GRASS CROP, ITS DEVELOPMENT USE AND MAINTENANCE," (SPON)

Trials were made at Wye College where pastures and leys were sown after harvest. Mr. J. Merridew, the then Lecturer in Farm Mechanisation at Wye College, found that Rotavation gave just the right shallow seed bed with minimum loss of moisture.
The stubbles were Rotavated to a depth of 1-2 inches only and a fine seed bed prepared in which the grass seeds were sown. All that remained to be done was rolling and, provided that the date of sowing was not delayed after the first few days of September, clovers too could be established safely before the hard weather set in. As an example, shed grain from a barley crop harvested in the first week of August acted as a nurse crop and grazing was possible as early as the first week in September.

It would be extremely risky to attempt a sowing of grass seed at this time of the year, with cultivations based on ploughing.

"By cultivating the stubble as soon as possible after harvesting, weed seeds and shed grain can be germinated, the latter providing useful keep in addition to the sown catch crop."
—J. MERRIDEW, M.SC., IN "ROTAVATOR PICTORIAL" (NEW SERIES NO. 8)

Catch crops for Autumn or Spring feed are not uncommon but, to be worthwhile, there must be as little delay as possible between harvesting the previous crop and sowing to avoid loss of moisture. Merridew broadened his trials on pastures and leys to include catch crops which could be fed off before the turn of the year. He was of the opinion that it would be easier to send off fat sheep from a good catch crop such as rape, rather than from an Italian rye grass stubble in Autumn.
Trials were made after barley but catch crops can follow any white straw crop, early potatoes or peas. The catch crop may consist of rape, turnips, mustard or a mixture of the three. Rye and ryegrass can also be used, especially for rather later feed after the turn of the year. They may also be sown considerably later.
The seed bed should be prepared by Rotavation at a depth of 1 to 2 inches after harvesting a crop and the earlier sowings should be consolidated.
When making the Spring seed bed, Rotavation after feeding off incorporates the residue of the crop and the dung.

for reclamation in forest and in scrub

Rotavation has been used extensively in light and heavy reclamation. Many farmers have found a continuing and regular use for their machines on minor works such as control of hedge rows and headlands as well as complete reclamation from scrub. Both market and private gardeners find that even the lightest machines do useful work. The heavier hand-controlled machines are regularly used in grubbing out shrubs and bush fruit plantations. In forestry, special heavy types of Rotavator are used successfully but these larger machines are normally employed by contractors.

(1) On Heathlands and Scrub

If trees are present, they should first either be winched out or cut and the main bole with its roots removed by blasting.

The land should then rough levelled. Rotavation alone can reduce or eliminate the necessity for bull-dozing, since holes and depressions can be filled in by crossing repeatedly with the Rotavator with the shield up, or back-filled by backing the Rotavator carefully towards the holes. Alternatively a tractor with a light angle-dozer in front and a Rotavator behind, can work wonders.

The land may now again be rotavated and saplings need not be cut first. Some prefer, however, to burn off the scrub.

The first pass should be shallow. Where a large obstacle is known to be in the soil, the tractor should be run at half-throttle to reduce the impact.

Further passes are next given and these should be crossed in several directions, as this will help to level out any depressions. The depth should be increased gradually at each pass, so that no roots are left whole to damage conventional implements at normal working depth. Rotavation lacerates the bark on the saplings and branches turned in, so that decomposition is accelerated; gorse, bramble and scrub are eliminated.

During the final passes, fertilisers and lime may be mixed in and an autumn crop may be taken.

(2) Copse and Woodland

On many farms, there exist the remains of spinneys, copses or woods which have been felled. In some cases, sufficient good timber remains to cover the cost of reclamation. Such areas, after reclamation are generally put down to grass for the first few years.

To begin with, any large trees are cut and felled. The boles are treated with a suitable decomposition accelerator and, for the remainder, rough levelling is done as in the previous sub-section on Heathlands and Scrub.

Rotavation is carried out as before, that is so that each pass crosses, care being taken to ease the Rotavator over the stumps.

Each pass is increased in depth unless or until too much sub-soil is being mixed in with the chopped up and lacerated undergrowth.

In a few years time the old stumps and boles will have vanished and the Rotavator will remove all trace when the pasture falls due for cultvation.

(3) Old Degenerate Grassland

The method of reclamation is similar to that recommended in the breaking of pastures and leys.

The first pass should be given at a low ground speed and at shallow depth, to get the maximum cutting and mixing of the grassy mat.

The depth may be increased at each subsequent pass, when lime and fertilisers may be added.

On uplands where large boulders and rock may lie close below the surface, care must be taken to see that the safety clutch mechanism of the Rotavator is

functioning properly and obstructions either avoided or eased-over by operating the hydraulic lift.

"It is indeed a very desirable piece of equipment to have at ones disposal—one is tempted to say an essential piece of equipment."

—FROM THE FULL REPORT OF TRIALS CARRIED OUT ON BEHALF OF THE FORESTRY COMMISSION, PUBLISHED WITH THEIR CONSENT BY ROTARY HOES LIMITED.

(1) The general principles set out in (**a**) (1) and (2) of this section apply equally in forestry.

The reclamation depends on what the future purpose of the land is to be. Normally, it will be reset to timber. If not, what has been said on farm methods applies.

It is common to find that the drainage on reclaimed woodlands is poor and that only main ditches or dykes exist. In consequence, really deep working is not desirable. Rotavation mixes the old forest floor, which is rich in organic matter, and prepares ideal conditions for reafforestation while controlling weeds and scrub.

(2) In stands of young timber, Rotavation is used for weed control and the creation of rides.

(3) It is also used for making fire-breaks.

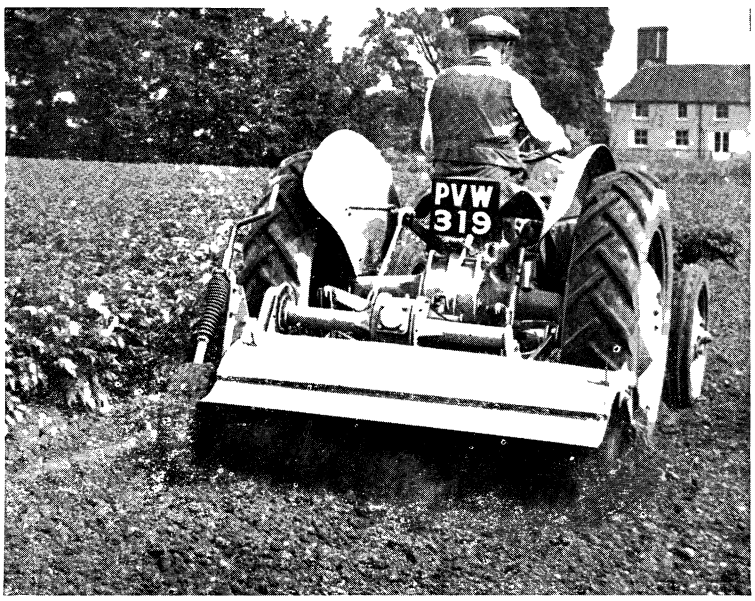
(4) Rotavation creates the ideal soil mulch for nursery stock.

for other applications

In the course of the past few years farmers, market gardeners and private gardeners have all found uses for the Rotavator outside the main purpose for which it has been produced. All the hand-controlled machines can be provided with attachments. The larger machines can be fitted with : Picktine Rotors, Soil Shredders, Rollers, Power Take-Offs, Furrowers.

On the smaller machines the following attachments are available : Cutter Bars, Lawn Mowers, Tool Bars, Side Hoes, Saw Benches, Sprayers, Trailers, Water Pumps, Transplanters, Seeders, Hedge-Trimmers, Generators, Compressors.

Special Picktine rotors are available on tractor-operated models for Chisel and pasture renovating or Lucerne blades. A special rotor is needed for the Coffee blades.



(1) Rotavation for Clean Headlands

The encroachment of weeds and hedge row plants reduces the area of farming land available.

In certain row crops such as Sugar Beet and Potatoes where, during the growing season, it is necessary to leave a headland, the latter tends to get foul with weeds. Rotavation not only controls these weeds but prevents weeds from spreading into the crop.

(2) Rotavation in Hedge Cleaning

The combination of Rotavator and hedge trimmer has been used with success. The rotor will get right under the hedge, levelling the surface and taking out excess root growth while the trimmer cuts back the hedge.

These operations can be done separately when the Rotavator mulches the hedge trimmings into the soil.

(3) Rotavation in Levelling of Lands

Where mole hills and ant heaps, as on some semi-derelict land or neglected pastures, create special problems, these may be levelled off by the Rotavator.
The rotor is set so that it skims the soil surface. The back shield is raised so that the soil is scattered evenly over the land.

(4) Rotavation and Ditch Cleaning

The spoil from the ditch after cleaning can present a problem. Like levelling off, the rotor is set to skim the main level of the field. The shield is raised so that the soil on rotavation is thrown out and spread.

(5) Back Filling

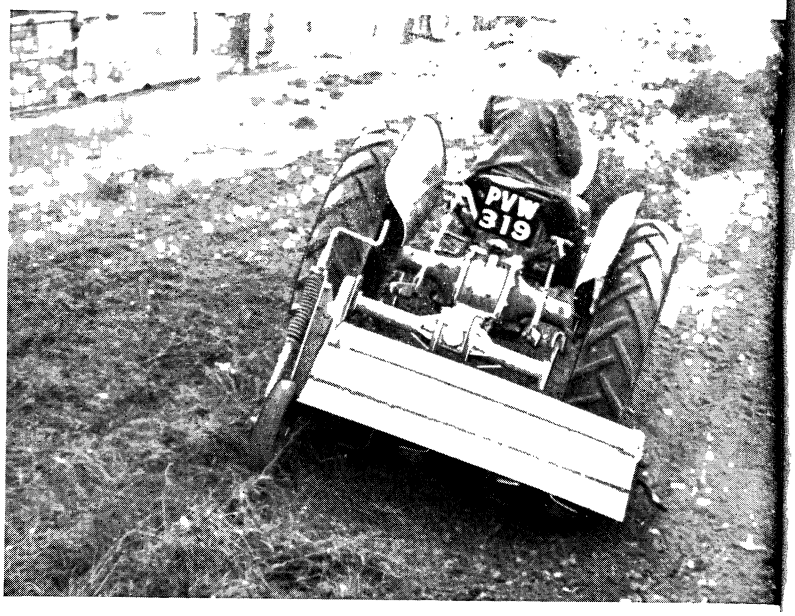
Similarly, the Rotavator has been used for back-filling. In this instance, the tractor is backed towards the spoilage with rotor set to the normal field level, with the rear shield right up. Backing-in enables the operator to direct the soil to a low spot or to some point which needs filling.

Picktine rotors may also be used for this work and may be found to be more suitable on gravel roads or paths which are more compacted.

(9) Levelling Off Banks

Banks and hillocks may also be levelled off by Rotavation. Hillocks can be treated in a similar way to mole hills but banks or raised contours require slightly different treatment.

Shallow banks are rotavated with the rotor set to skim the normal levels. The shield is left up. Instead of however, going over the bank at right angles the tractor should be taken along the contour and at a slight angle to it, so that the soil is thrown out behind and slightly to one side of the contour.



(6) Marling

This operation is similar to dung spreading. The marl is set out in heaps in rows across the field. The rotor is set to skim the normal level. The shield is raised. By travelling across these small heaps on the diagonal, the marl may be evenly spread and distributed.

(7) Cart Trucks and Ruts

In the course of a season, farm tracks become deeply rutted and the movement of plant and machines becomes difficult.

Tracks and ruts can be cut out by the Rotavator by setting the rotor to cut into the rut. According to the condition, the shield may be raised or lowered.

Where the soil is required to remain in the same area, the shield is lowered but where there is a hollow to fill, as in back filling, the shield is raised.

(8) Cleaning Dirt and Ash Roads

On farms and holdings where such roads exist, weeds can present a problem. Rotavation is the answer. Either the hand-controlled or the tractor-drawn models are equally suitable.

The rotor should not be set too deeply. Where the normal blades are used, they should be set to cut about 1-2 inches below the surface.

(1) Soil Sterilisation under Glass. Steam Sterilization:

At medium pressure, rotary cultivation of the soil before sterilisation has been found to give a reduction in the amount of steam used. The efficient and economic use of steam is of paramount importance in this costly operation. The high cost of steam sterilisation has also led to developments in methods and equipment.

Elsewhere, in place of the Hoddesden type steam pipe, combs have been re-introduced. With these it is possible to make further economies for :- -

- the paths are no longer steamed and become completely consolidated between the plant rows.
- the plant rows themselves are only steam sterilised.
- deep digging Rotavators have been developed to eliminate hand digging.

The plant rows are thus deeply rotavated. The combs turned on and the sterilising can be done by one man, apart from the stoker, using three sets of steaming combs.

(2) Chemical Sterilisation of Glasshouse Soils

After the plants have been cut down and removed, the consolidated soil is rotavated in order to remove lumps which might otherwise not be penetrated by the sterilising fluid. This also ensures that the chemicals which are put down in dilution penetrate the soil evenly.

(3) Potting Soils

In the growth of seedlings and pot plants, large quantities of proper growing composts are required.

Many growers have their own ideas of mixtures but efficiency depends on the mixing, whether the user follows the recommendations of the John Innes Institute or prefers his own formula.

It is not necessary to have a special machine for this work. The larger hand-controlled models have soil shredding attachments, but for those who do not feel justified in obtaining such an attachment, the following method is satisfactory.

The soil to be mixed is spread on a hard level surface, preferably concrete. The area is a matter of convenience but the depth should not exceed 6-7 inches.

Where the John Innes mixtures are used, a suitable equivalent of very sharp sand and peat are placed on top of the soil and finally the fertilisers are spread over the whole surface. The final heap should be rectangular and not more than 9 or 10 inches deep.

The hand Rotavator, with the shield down, should be run several times both ways over the heap. Any soil thrown out should be put back on top each time.

Where the soil is very rough before mixing, it may be broken down in a similar way. It should not be bone dry or it will not break up readily. Turfs may be treated as well.

(4) Deep Litter Hen Houses

Rotavation is used to break us and aerate the litter and thus encourage bacterial action and speed decomposition.

Wet spots in the litter, either around the drinking troughs or where rain has got in, may be eliminated by Rotavation.

(1) The establishment of sward is a normal part of the Groundsman's task and the improvement of structure is dealt with in Section

F (f). The maintenance of an established sward requires that the very worn areas after say, the football season, require re-seeding.

The seed bed given by Rotavation will ensure a quick and early germination of grass seed and these areas can be rotavated with confidence.

The take of turf where this is laid is greatly assisted, too. Gypsum, fertilisers or soil conditioners can be worked in while rotavating.

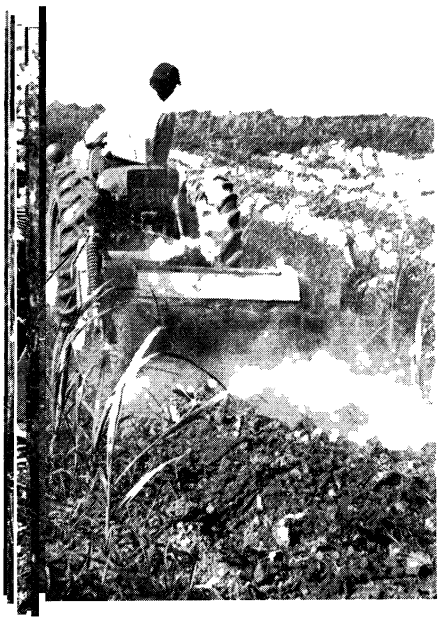
(2) Rotavation is used by the makers of grass tennis courts, both to assist in the operation of cutting and levelling and in preparing the ground for sowing or turfing.

(3) Rotavation is also used by the makers of hard tennis courts, not only in helping with the cutting and levelling but also in the mixing and grading of the aggregates.

(4) Rotavation is also used in the upkeep of paths and drives.

in Tropical and Sub-Tropical Conditions

The principles of agriculture are the same the world over. The preparation of the seed bed, the control of water in the soil, the maintenance and improvement of soil structure, and the eradication of weeds are universally important in crop production. The cultivation of the soil plays an important part in these essentials. The relative importance of individual factors varies in different parts of the world. For example, in some areas the removal of excess water from the soil is a major problem while in others the conservation of soil moisture is the most important. Since the factors influencing crop production are common to all areas, ROTAVATION, as described earlier, can equally well be applied to deal with these factors provided due allowance is made for the different circumstances.



Sugar

Sugar

Coffee

In many parts of INDIA a small deficiency in rainfall produces famine conditions. As many as twenty cultivations with normal implements may be given in these areas to produce a seed bed. These cultivations involve considerable loss of soil moisture. ROTAVATION could produce a seed bed often in as few as two passes and thus conserve the moisture in the soil.

Weeds similar to Couch are common throughout the Tropics and sub-Tropics. The same methods of ROTAVATION which have been proved to control Couch and Twitch in Britain (See Section D (c), Page 10) can be equally well applied elsewhere.

The mixing of crop residues with the soil to maintain soil structure is probably even more important in the tropics than in the temperate regions and ROTAVATION therefore is of greater importance under Tropical and sub-Tropical conditions.

In Tropical and sub-Tropical areas the altitude and amount and distribution of the rainfall are important factors influencing the types of crops grown and the problems associated with the cultivation of the soil. While variations occur in details, the Tropical and sub-Tropical areas, can, in general be divided into four zones :—

(1) A hot moist zone, generally near the coast, which may be situated in the area between sea level and 1,500 ft. high.

(2) A hot dry zone with rainfall confined to a few months of the year. Areas of this type are either under grass and scrub, or carry one crop a year unless irrigated.

Citrus Fruits

(3) A zone from 2,000 ft. to 4,000 ft. altitude with a high rainfall, but also one or more dry periods of some months duration. Lateritic soils frequently occur in this zone and their cultivation presents special problems.

(4) A cool or montane zone from 4,000 ft. to 8,000 ft. altitude with evenly distributed rainfall, which may vary from some 60 to 150 inches or more per annum. Lateritic soils may occur in the lower portions of this zone and heavy clays in the higher. Sub-Tropical crops can be grown at the lower levels, and many crops of the temperate regions in the higher.

The principles of ROTAVATION as established in the temperate regions can be applied throughout these zones, provided that proper account is taken of the special requirements of the climate, rainfall and crops.

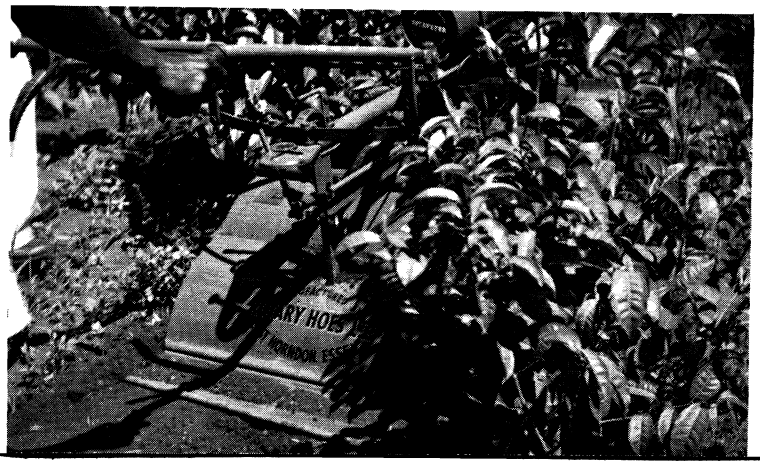
Rice

Sugar cane is usually grown in a hot, humid climate, alternating with dry periods at low elevations on the heavier soils. Propagation is by setts, the space in between the rows varying according to variety and local conditions. The first harvest is usually 14-20 months after planting. The rootstocks continue to crop for several years and are known as ratoons. The main problems are inter-row cultivation to maintain soil fertility and control weeds and the disposal of trash. ROTAVATORS of suitable widths for inter-row cultivation have been widely used to carry out the operations. After harvest ROTAVATORS are used to **break** down the trash, cut it, and incorporate it with the soil to maintain soil structure, throughout the period of the ratoon crops. ROTAVATION is also used for breaking up the stools at the end of the ratoon crops period, in preparation for the following crop.

Rice

Maize is usually grown at medium to high elevations in the tropics or sub-tropical and warm climates. The ground requires to be well tilled and ROTAVATION is excellent for this purpose. Maize is usually planted in rows about 3 ft. apart. Hand-controlled ROTAVATORS are used for inter-row cultivation. ROTAVATION is also used to dispose of the Maize stalks by turning in after harvest.

Coffee is usually grown in the lateritic type of soil with a rainfall distributed so that there are well defined wet and dry seasons. The conditions under which coffee is grown in Kenya, which has been studied by Pereira and Jones, may be considered as representative. It has been shown in Kenya that weed control is essential to prevent competition with the crop for the available soil moisture, and that the operations to control the weeds must be carried out in such a manner as to leave the soil surface in clods so that the maximum amount of rainfall may enter the soil thus reducing the run-off and soil erosion to the minimum. The special Coffee Rotavator has been shown by Pereira and Jones to effectively control the weeds and to produce the type of tilth required. It is now widely used in Coffee Plantations.



Tea is grown from sea level to about 6,000 ft., frequently on the lateritic type of soil. Seedlings are planted at about 4 ft. x 4 ft. spacing. The plants are pruned to induce branching and a bushy habit and to control the height of the bushes. The prunings are mixed with the soil to provide humus and cultivations are carried out to control weeds. Both these operations are effectively performed by the hand-controlled ROTAVATORS.

Tea

These are usually grown on light, friable soils which have to be well tilled. ROTAVATION produces an ideal tilth. The crop is usually sown in rows 2 ft.-2½ ft. apart. Inter-row cultivation can be carried out with hand-controlled ROTAVATORS.

Vines

Ground to be sown or transplanted with rice is usually cultivated after the first rain or irrigation to break up the old stubble and to kill the weeds. After preliminary operations the land is flooded and worked to puddle the soil. ROTAVATION has been widely used for the preliminary cultivations and has been especially valuable in thoroughly puddling the soil which is so necessary in many areas for successful rice production. In addition to the tractor-operated ROTAVATORS, a special hand-controlled model has been designed to ensure its efficient working under the wet conditions necessary for the final preparation of the seed or transplanting bed.

ROTAVATION in the vineyards in temperate climates has long been common practise. In the vineyards of South Africa lupins are frequently grown between the vines to provide green manure. ROTAVATION is used for turning in the lupins and for other inter-row work.

Vines

Citrus fruits are generally grown on land situated between sea level and about 4.000 ft. The spacing depends upon the variety of the crop and the nature of the soil. The spacing varies from 15 ft. by 12 ft. on the poorer soils and to 25 ft. by 20 ft. on the rich soils. Mulching and the control of weeds are the main cultivation operations. ROTAVATION is used for these purposes.

Dates are grown in areas with a high temperature for a considerable period of the year, usually on a heavy soil. In many areas the control of a type of grass resembling couch is important. This grass can be eradicated by a succession of ROTAVATIONS.

Cassava

Standard applications of ROTAVATION such as the preparation of seed beds, weed control, green manuring and the incorporation of crop residues have been applied to many other crops such as :–

Pineapple, Banana, Papaya and Mate.
Cotton, Rubber, Sisal, Tobacco and Pyrethrum.
Sorghum, Millet and Cassava.
Yam.

Pineapple

for special industrial applications

Building contractors use Rotavation both in the preparation of sites and also in the restoration of the surround-land after building operations.

Both tractor-operated models and hand-controlled Rotavators are used in—

(1) The preparation of sites

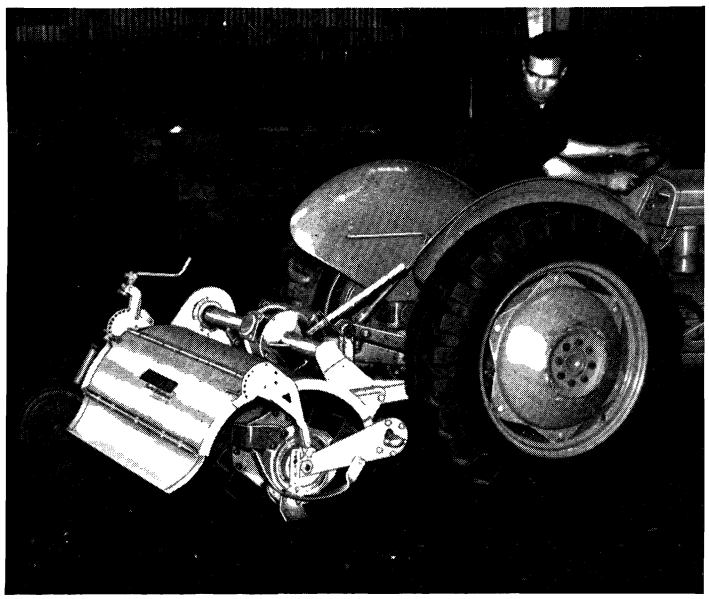
Rotavation can be used for minor levelling work and much of the work of the Bulldozer may be either cut out or greatly reduced.

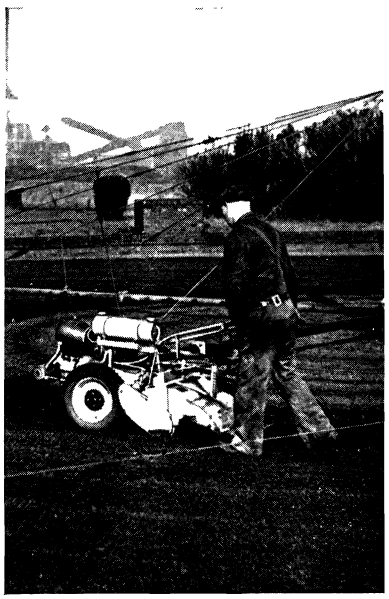
(2) The preparation of footings and foundations for houses

The hand-controlled machines are used for loosening the soil so that the foundation of the wall may be laid. Two or three passes are made following the plan of the walls and the soil thus loosened is shovelled out. Extra depth may be obtained by repeating.

(3) Trenching for Drains and soak-aways (also for Water, Gas and Electricity Supplies)

Hand-controlled machines are used to prepare the work for shovelling the trenches, thus speeding and lightening the labour.





(4) Restoration of Sites following completion of works

This somewhat resembles reclamation work (Section K). Where it is known that the land surrounding the building must be restored, either for grass or cultivation, it is important that any top soil should, at the outset, be put on one side so that it may be replaced afterwards in the same relative position.

Section H deals with what work is necessary where there are large holes following tree clearance.

Where considerable soil, especially clay from the lower spits, has been spread or is to be spread, the same method may be used as suggested in section F (f).

(5) Sewage Disposal Works

Clinker beds become foul in the course of time and it is necessary to turn the clinker to give aeration. Rotavation enables this essential operation to be done rapidly and thoroughly.

The larger hand-controlled machines have been used most successfully for this type of work.

(6) In modern Foundries

Both hand-controlled and tractor-operated Rotavators are in use for turning and aerating foundry sand.

(7) In the Gas-works

Rotavation can be used to revivify the iron oxide when it has reached saturation point in the normal purification process.

The method is to remove the spent iron oxide from the purifier boxes and spread it on a hard standing, allowing it to cool. It may then be rotavated and broken down into small pieces and aerated at the same time. For this purpose the larger hand-controlled machines are used.

In compiling this booklet, we would like to express our thanks to the publishers mentioned below for permission to quote extracts from the following publications.

"Agriculture, the Science and Practice of British Farming" IX Edition (the X Edition, which is revised and enlarged, is now available)
Sir James Scott Watson and James More
Oliver and Boyd Ltd.

"Soil Conditions and Plant Growth" VIII Edition
Sir John Russell, D.Sc., F.R.S.
Longmans Green & Co. Limited

"The Grass Crop, its Development, Use and Maintenance"
Dr. Williams Davies, D.Sc.
E. and F. N. Spon Limited

"The Use of Lime in British Agriculture"
H. W. Gardner and H. V. Garner
E. and F. N. Spon Limited

"Journal of Agricultural Engineering Research." Vol. 1, No. 1. H. Fail, B.Sc., on "The Effect of Rotary Cultivation on the Rhizomatous Weeds" and also Vol. 2, No. 4.
National Institute of Agricultural Engineering

"Farm." Vol. II, No. VI
J. Merridew, M.Sc. (extracts from an article)
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Throughout the booklet many references and quotations are given from accepted authorities and publications dealing with agricultural and horticultural subjects. Rotavation has been developed in accordance with these principles and their inclusion is to remind readers the debt we owe to the past as well as to those whose work continues further trials and experiments.

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