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Chemical renovation of grassland

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Summary

In general, the new practical prospects opened by chemical grassland renovation are very few: the old grass sward is inadequately killed, seedbed preparation requires rather intensive soil tillage and the method is expensive. The construction of a new type of rotavator, moreover, has taken away many drawbacks of the earlier method of grassland renovation.
Only in some special cases, chemical grassland renovation can be applied:
— in fields with many plant species that cannot or hardly be mechanically controlled (couchgrass, tufted hairgrass);
— in fields which cannot be mechanically tilled (steep hills, stony soils, etc.). In view of the high cost of renovation, the rather variable results and the rather extensive use of many of these grasslands, chemical renovation is neither advisable in these cases.

Introduction

The botanical composition of many grasslands is so poor that the quantitative and qualitative production of fodder is insufficient to feed many and high-yielding cows. In the intensification of cattle-farming grassland renovation is therefore often a necessity (grassland still being the cheapest source of cattle feed).
When the percentage of good grasses in the sward to be renovated is reasonable (e.g. over 50% perennial ryegrass) it can often be greatly improved in a short time by improving the growing conditions of good grasses (suitable use, good fertilizer application and drainage), possibly supported by selective weed control.
However, when the sward consists mainly of poor plant species, reseeding will often give a more rapid and better result. Reseeding means killing the old grass sward, preparing a seedbed and sowing grass and possibly clover seed.

Killing of the old sward

The old sward was and is nearly always destroyed by ploughing or by rotavating. In ploughing the sward is buried and killed by smothering. With the rotavator it is chopped into small pieces which are left to dry out. However both methods present rather many practical difficulties:

— It is difficult to plough well, seedbed preparation requires a fair amount of labour and the end furrows have to be filled in.
— The main difficulty in rotavating is that dry weather is needed to kill the old sward (whereas much moisture is required for the seed to germinate!).

In addition to these drawbacks of the old methods of destroying the sward, there are vast areas of grassland which cannot or can hardly be mechanically treated: on heavy soils, on soils with a low bearing capacity, on stony soils, on steep hills, etc. Finally, there are many grasslands with species that cannot or can hardly be mechanically controlled: couchgrass (*Elytrichia repens*), tufted hairgrass (*Deschampsia cespitosa*), tall fescue (*Festuca arundinacea*), etc. The application of broad-spectrum herbicides in grassland renovation opened therefore many new prospects.

Chemical renovation

In recent years, especially after the introduction of paraquat, a great number of papers have been published on the chemical renovation of grassland. Yet this method is not at all new. Already in the past, the grass sward on soils with a low bearing capacity was killed by applying a mixture of corrosive fertilizers (kainite, calcium cyanamide and powdered superphosphate), and after very extensive soil cultivation the land was reseeded with grasses.
Under favourable conditions the grass sward was completely killed by this method; usually, however, this method was not sufficiently effective. After this period, successive trials were conducted with sodium chlorate, TCA, dalapon and weedasol, but the great drawback of these chemicals was their long persistence in the soil. After the introduction of paraquat (Gramoxone) round 1960, the chemical renovation of grassland was in the limelight again. This herbicide acts rapidly, is rapidly inactivated in the soil and kills a broad spectrum of species.

Paraquat

Since its introduction, many experiments have been conducted in many countries on the application of paraquat and it was established that the theoretical promises were hardly fulfilled in practice:
— the chemical is not active against all species;
— a good seedbed is needed for the proper establishment of grass and clover seed;
— chemical renovation is expensive.

Paraquat is not active against all species. The tolerance of the various species to paraquat is difficult to exactly indicate, because it is very much dependent on the conditions, viz the time of spraying and the condition of the sod. In spite of this a rough distinction can be made in the tolerance of species:
very sensitive: *Holcus lanatus, Poa trivialis, P. annua, Anthoxanthum odoratum, Molinia coerulea* and *Lolium multiflorum;*
moderately sensitive: *Dactylis glomerata, Phleum pratense, Lolium perenne, Festuca pratensis, Deschampsia cespitosa* and *Festuca arundinacea;*
rather tolerant: *Elytrichia (Agropyron) repens, Festuca rubra, Alopecurus pratensis, Phalaris arunudinacea* and *Glyceria fluitans,* many dicots, *Carex* spp., *Juncus* spp. and *Equisetum palustre.*
In surveying this list it can be seen that many plant species cannot or hardly be con-

trolled by paraquat and also that these are the very species which are found in poor grasslands.

Preparation of the seedbed

Mechanical treatment of grassland, in addition to being applied to kill the sward, was to prepare a good seedbed for sowing grass or clover seed. Spraying with paraquat, on the other hand, only kills the old sward and a seedbed still has to be prepared. Initially, hopes had been high that the seed could be sown successfully in the dying sward without additional soil cultivation; however, the results obtained in this way were so inferior that preparation of a seedbed was found to be indispensible. (A solution which may sometimes be successful is to apply intensive grazing — or rather forced treading — of sheep or cattle, immediately after sowing.) The considerable amount of work done on the most advisable way of seedbed preparation showed that rotavating gave the best results.
The results with the introduction of a new type of sowing machine, the sodseeder [1], with which the seed is sown in rows in the killed sod by means of a very light (local) soil tillage, were as yet neither very promising with regard to the soil cultivation problem. In general, the grass seed establishes poorly and the old sward may recover from the paraquat treatment, because the supporting control (intensive rotavating) is omitted.
All this has been a set-back in fulfilling the promises of chemical grassland renovation.

Renovation of grassland on soils which cannot or are difficult to cultivate mechanically

Because the chemical destruction of the sward has to be followed by intensive soil cultivation to prepare a seedbed, the prospects of chemical renovation of this type of grasslands are little better than those of mechanical renovation. At most, the sward can be chemically killed (5 to 7 l of Gramoxone per ha) round about July or August, after ten days reseeding the grassland after light tillage of the soil (e.g. harrowing), or after sowing trying to bring the seed into the soil by intensive treading of cattle or light tillage of the soil. All treatments, however, will give rather unsatisfactory results, because the old sod will partly recover (the activity of paraquat not being supported by mechanical treatment) and the seed will establish poorly (poor seedbed).
In view of these inadequate results, the cost of the treatment and the often extensive use of the relevant grasslands, it remains a very doubtful question whether chemical renovation will be a widely applied method on these grasslands.

Renovation of grasslands with many weeds that cannot or hardly be controlled mechanically

Two plant species offering many difficulties in the mechanical renovations of grassland are: tufted hairgrass (*Deschampsia cespitosa*) and couchgrass (*Elytrichia repens*).

Tufted hairgrass. This species can be well controlled by ploughing it completely into the soil. However the quality requirements of plough and ploughman are pitched so

[1] There are several types of these machines, viz the 3-D drill, the Howard rotaseeder and the Sisis contravator.

high that satisfactory results are only seldom obtained in practice (mainly grassland areas!).
An additional problem in the control of hairgrass is that it mainly occurs on soils with a high humus content, of which the drainage is more or less inadequate. In ploughing such soils there is not only the risk of getting stuck, but also of the bearing capacity of the soil decreasing so much by ploughing the old sod that the risk of treading the young sward is great.
Unfortunately the many experiments in which paraquat was used in the renovation of such grasslands gave inadequate or even unsatisfactory results; in most instances hairgrass was insufficiently controlled [1] and the preparation of a suitable seedbed for which intensive rotavating is indispensible, was often impossible on these soils. Much better results were obtained in controlling hairgrass by sodium chlorate (150 to 200 kg of the 98% or twice this dose of the 50% formulation) in a period of grass growth. For a good result it is crucial that the grass grows, because the effect is partly due to the uptake of chlorate ions by the plant. In view of the persistence of sodium chlorate the most suitable application (spraying or sowing) time is in autumn (September or October), after which rotavating and reseeding can take place in spring.
The results of this kind of renovation are generally very good; however, a few failures have occurred on a number of fields in recent years, because some time after reseeding hairgrass recurred in great numbers. The impression was gained that this was due to the establishment of seedlings. Germination experiments indeed showed that considerable quantities of viable seed occurred on the various hairgrass fields, varying within a range of some hundred thousands to 10 million seeds per ha in the layer 0–5 cm.
Even in this control measure, with sodium chlorate the mechanical seedbed preparation remains indispensible, while at the same time its high cost may be a drawback. Recently, however, good results have been obtained with a new type of rotavator, described later in this paper, provided the hairgrass is buried at least 12 to 15 cm; the cost of this treatment is much lower (no herbicides).

Couchgrass. Although couchgrass can be controlled by suitable grazing (very frequently and shortly), in practice this is often not realizable, and therefore more drastic measures are required. Usually, just ploughing up the sward or rotavating rarely controls couchgrass adequately; supporting measures as fallowing for some time or growing one or more heavy arable crops are essential. However especially on grassland farms these measures present so many difficulties that also for couchgrass control the use of suitable herbicides seems an attractive proposition.
Particularly, in arable farming the chemical control of couchgrass was studied in detail. These investigations have shown that TCA and, to a less extent, dalapon and amitrol could give reasonable results. In grassland, at least with normal applications, the results were less satisfactory: the couchgrass was severely damaged, but rarely these measures present so many difficulties that also for couchgrass control the use completely eradicated. In addition, the long persistence of these chemicals necessitates spring sowing and in spring the establishment of grass and clover seed is often so slow that couchgrass will have ample time to recover again. In view of the high cost of this method, these variable results are inacceptable.

[1] The main cause of this probably is the difficulty of properly wetting the tufts of hairgrass with paraquat. Good control is indeed possible in individually treating tufts of hairgrass.

By immediately planting the land, after burying TCA in the soil with the rotavator, with forage rape or turnips (both crops are tolerant to this herbicide) the period of fallowing may be very much shortened, which will make this method more attractive. Moreover, both crops have a depressing effect on couchgrass.
In the last three years very good results have also been obtained with a new way of applying dalapon. In the past dalapon was usually applied to well-developed couchgrass in August or September, after which a crop could be grown only six to eight weeks later. In the new method the grassland is cut or grazed round July or August, couchgrass being allowed to form a reasonable leaf cover again in 10 to 14 days (dalapon is mainly taken up by the leaves). After this 20 to 25 kg dalapon per ha are sprayed, and 10 days later the land is rotavated (with the Lely rotavator to be discussed) and the grass seed sown. The control of couchgrass is here based on:

1 The activity of dalapon;
2 Burying by the buryvator (couchgrass is buried 10 to 15 cm into the profile);
3 Competition by the young grass sward (couchgrass plants possibly surviving treatments 1 and 2 and rising after some time to the surface are suppressed now by an actively growing young sward).

The young grass plants (e.g. perennial ryegrass) are not damaged by the dalapon in this way, not because they should be less sensitive to this herbicide than barley or oats (all three crops are about as sensitive), but because when dalapon is sprayed on a (closed) grass cover, it will hardly touch the soil. It is almost completely absorbed by the plant tissues and therefore cannot affect growth of the young grass plants.

Renovation of grasslands without couchgrass on soils that can be tilled mechanically
The unsatisfactory results, mentioned before, and the relatively high cost are the reasons that chemical grassland renovation has not grown into an alternative method of grassland renovation to the classical one, despite all its limitations. Only recently the chemical renovation has had another set-back by means of the construction of a new type of rotavator, the buryvator (Lely rotavator).

Lely rotavator. With the usual rotavators, two or more operations are necessary. First, the sward is cut into pieces and after some ten days for the pieces to dry out, a second rotavation makes the seedbed. When the weather is wet, the sward is not completely killed. This may lead to either a poor result or involve extra costs and a longer time without grass.

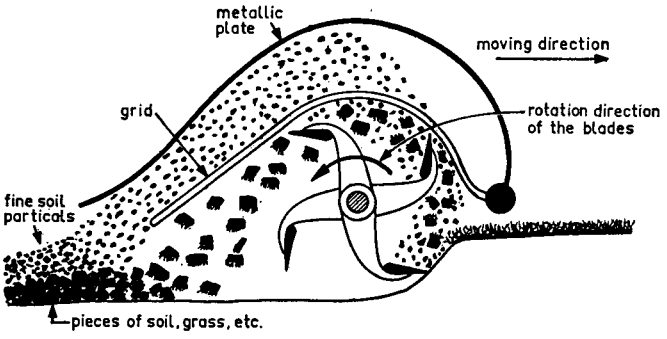

Fig. 1 Schematic presentation of the Lely rotavator.

In 1966, the Dutch firm Lely put on the market a new rotavator for grassland renovation which destroys the sward and at the same time prepares a good seedbed. With this new rotavator, the time between destruction of the old sward and reseeding the new one is only a few hours and the weather risk is reduced. In contrast to the older rotavators, the blades rotate in the opposite direction to the wheels of the forward going tractor. The sward is cut into pieces, which are thrown against a grid which returns the large soil and turf pieces into the hole just made by the blades. The fine soil particles pass through the grid, strike a metallic plate and fall down above the larger soil and turf pieces (Fig. 1).
Thus in one operation the sward is cut into pieces, the pieces are buried and a good seedbed is made. This rotavator can be used wherever the old rotavator or the plough could be used. The results of the last two years are very good, provided the soil is well rolled after sowing.
Last year this rotavator was equipped with a sowing mechanism for grass seed, a fertilizer distributor and a roll, so that at the moment all reseeding activities can take place in one operation: destruction of the old sward, preparation of the seedbed, sowing grass and clover seed, fertilizer application and rolling the soil.

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