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Landbouwproefstation
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INTERNATIONAL PEAT SYMPOSIUM

Under the Auspices of Bord na Móna

SEPARAAT

DUBLIN, JULY 1954

SECTION F.2.



Reclamation — Agriculture and Soil
Conditioning

X₂ AN ORGANIC SOIL CONDITIONER PREPARED FROM PEAT

by

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SUMMARY

SOIL CONDITIONING MEANS changing a heavy sticky soil structure into a crumbly fine porous structure which is easily worked.

When soils become wet and swell they reach a sticky, pasty point. For clay soils this sticky point is at a low moisture. Porous crumb aggregates have a much higher sticky point.

A study of this problem showed that repeated application of farm-yard manure, composts and town refuse acts favourably in ameliorating heavy soil structure, and in the long run this raises the sticky point considerably in the moisture scale. This method however is a long term one and expensive, so it was decided to attempt to make an artificial stable organic humus by chemical preparations of sphagnum peat. Peat moss being expensive, older black peat was chosen as the base.

By intermittent reduction and oxydation, with the application of oxygen and ammonia to the black peat in an exothermically heated autoclave, a reaction occurs for some hours, after which it ends, no more oxygen being absorbed. The reaction is controlled between pH 5.9 and pH 7.8. A little alumina in the form of al sulphate is added in a certain proportion to the natural SiO₂ content of the peat.

The product known as X₂ is a fertiliser as well as a soil conditioner, and extensive tests over many years in pot and field experiments showed increases in crop yields of up to 25% by weight.

1.

SOIL conditioning means ameliorating a bad soil structure of a sticky soil, which consists of compact granules or even clods of large size and which is heavy to work when the soil is wet and impossible to work when dry, into a layer of fine porous crumbs, which do not stick together and which is easy to work. The structure of a soil depends on the " texture " and on the chemical and physical properties of the composing particles. The texture is defined by the size of the particles, their quantitative distribution in the system and their arrangement. As we are concerned, in this paper, with soils which have a high proportion of particles of less than 2 microns, we have first to consider the chemical and physical properties of this fraction. Heavy clay soils consist of 40 to 90% of such small pieces. Chemically, we must take

Fig. 3. Thin Sections. On the right, from a crumb on the plot treated with X_2 . On the left, from a clod on the untreated plot.

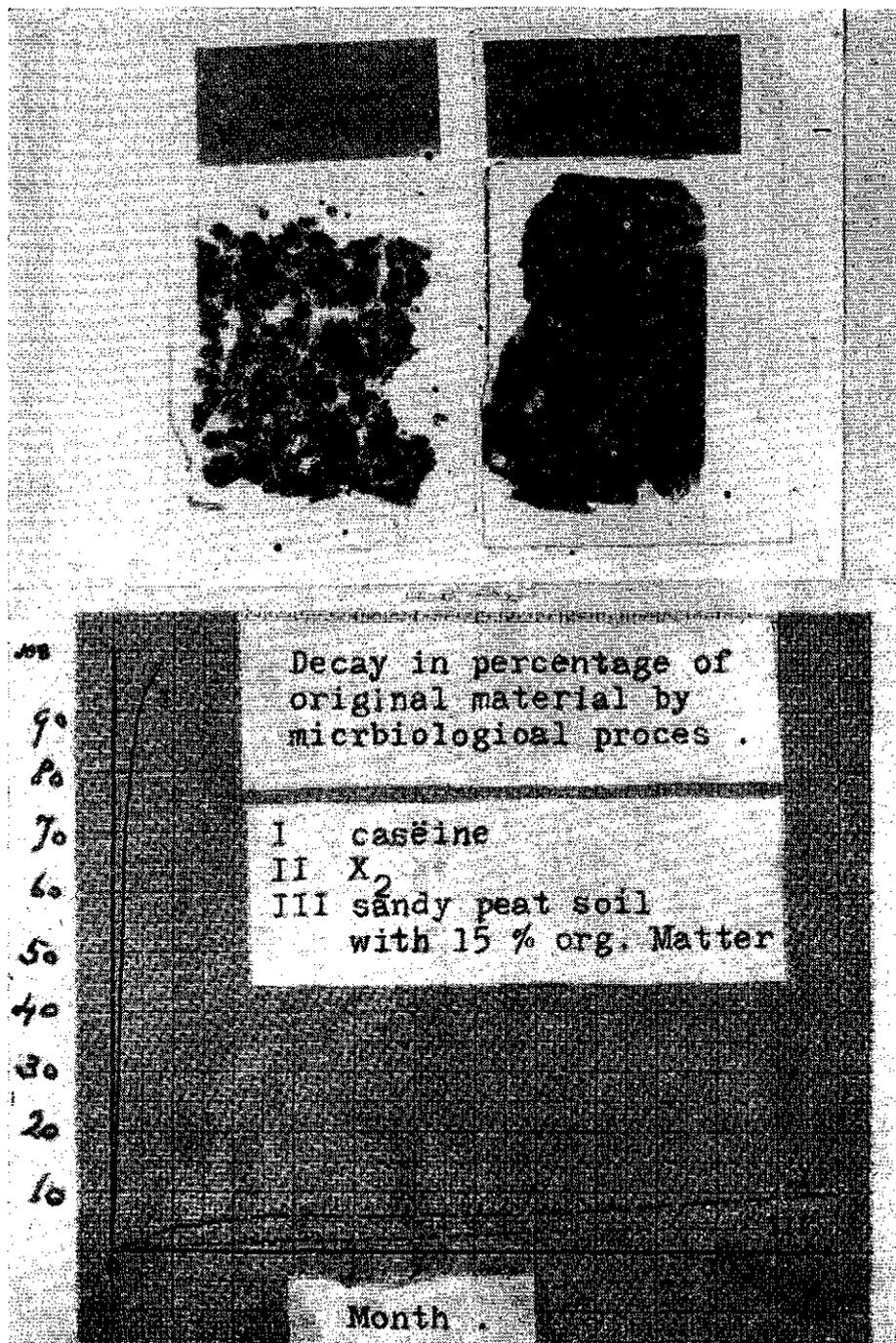


Fig. 4. Decay of casein, X_2 and a peat-soil with 15% of stable organic matter by bacteriological processes.

formed, with all the properties of real humus. Whereas stable yard manure decays in an aerated soil practically quantitatively, the organic matter in question remains stable even when a dead body of a cat or dog is buried in such soils; the body vanishes and the skeleton is left.

The way to effect a good structure with stable yard compost manure is a long term one, and at the same time expensive, so we ask—if an artificial stable organic humus-like compound can be chemically prepared from the same sphagnum peat. As moss litter is a material of rather great expense, we started with the older black peat formation.

We have to consider that this peat has a content of 14.4% waxes and resins, 11% of cellulose, 12.2% of hemicellulose (hexoses and uronic acids) and 59% of lignins. There is no doubt, that wherever a stable humus-like compound could be transformed from this material, the problem was limited to the question whether all these compounds could contribute to the forming of a stable humus-product. The humification of cellulose, hemicellulose, proteins and lignins has been studied by several scientists. We will not discuss this extensive research work in this paper and refer only to Waksman's "Humus" and to Hudig and v. Reesema's study of the problem of the stability of humus product.³

Now we will describe only the main lines along which we succeeded in preparing a product with the required properties, up to technical scale production.

Our analysis of the stable humus in the field always showed a content of 5% Nitrogen in Kernel-binding and further of Al and Si all soluble in Ammonia, with absence of bi—and trivalent cations, so that we concluded that these elements are essential to the stable humus. Studies in the field showed that the stable humus could be formed only from products which have existed in an anaerobic state for a long time, and, by reclaiming the peat soil into arable land (using organic offal, leaving, after mineralisation, a compound of Al and $\text{SiO}_2 \cdot n \cdot \text{aq}$)—existed afterwards in an aerobic state. It was decided, therefore, to venture an experiment with intermittent reduction and oxidation. As reduction processes under normal circumstances are very slow, oxidation of peat by absorption of oxygen only occurs by alkaline reaction, as an auto-oxidative reaction. As higher temperatures accelerated the reaction we heated the peat at a certain moisture content and with hydrolysable Al-silicates in thin layers at 100° C. We found some transformations, but not effective ones, so after these first trials we used autoclaves, with a mixer, at a pressure of 5 atm. and 125° C, adding first NH_3 to attain an alkaline-reaction by which an oxidation starts immediately forming humic acids and effecting a considerable acidification. The reaction proceeds with exothermic heat production.

Many variations in pressure and temperature by varied doses of oxygen and ammonia were carried out. In short, we will mention that with low pH, below about 5.8, the material begins to produce too much carbon dioxide and effects a loss of material. With pH's above 7.5 an absorption of oxygen occurs also with a loss of material. Less carbon dioxide is produced, but more water. By intermitting the addition of ammonia and oxygen (air) causing an absorp-

tion of oxygen, giving an acidifying effect, forming COOH-groups, but not lower than pH 5.9, and afterwards supplying more NH_3 and air, but not higher than pH 7.8, the reaction ends after some hours, when no more oxygen is absorbed. The reaction is controlled by taking samples of the material and of the gases.

Working in this way no material is lost, i.e. the yield is 100% since the loss in CO_2 is in balance with the absorption of oxygen. As the black peat contains a sufficient percentage of organic-bound SiO_2 but too little alumina, this element has to be added (e.g. as Al sulphate) in an adequate quantity and in a certain proportion to the natural SiO_2 content of the peat. The material is a real humus with the following composition (% of organic dry matter):

Carbon	...	...	...	...	...	53.9%
Hydrogen	...	...	...	...	...	5.9%
Oxygen	...	...	...	...	...	31.8%
Kernel nitrogen	...	...	...	...	...	4.3%
Exchangeable nitrogen as ammonia	...	...	...	...	...	3.9%

One of my colleagues, van Reesema, built the apparatus to enable technical study of the process. He came across the difficulty of effecting a reaction of a fine powdered peat material, of definite moisture content, with gases, but solved the problem. In order to get an idea of the costs of the manufacture for agricultural application, a pilot plant was built so that we could produce some hundred tons. At the same time this scientist thoroughly studied what happened in the autoclave. We will not discuss this extensive research work in his paper, but only stress his results by which it becomes clear that the essential part of the stable humus in the soil is obtained by the split up of lignin molecules by oxidising CH_3 -groups to COOH groups and phenol OH-groups, and binding the split up fragments by nitrogen, forming indol groups. He characterised this product as a condensation and a polymerised chinolinic and indolic compound with active COOH groups and phenol OH-groups which are partially blocked up by alumina and Si. (OH_2). The research took some years, during which time several products were tested in pot—and field—tests; these tests guided the technical progress.

That the final product X_2 is really a stable one is shown in fig. 4, where the decay of X_2 is compared with a soil containing 14% of stable humus and with casein. Pot—and field—tests, which are described in Section 3, showed that the after effect remains for at least two years. The experiments in the field on small plots showed a stability of at least 8 years.

X_2 contains exchangeable NH_4 which means that it is a soil conditioner as well as a N-fertiliser. In the following it will be shown that this N-fertiliser, combined with an insoluble micelle anion, is of high value, because it has no strong acid-anion as have sulphate or chloride and even amm. nitrate. X_2 is a fine black powder like soot with about 27% moisture. This content is rather high, somewhat higher than, for example, wheat-meal with 16 to 20% M.C., but in this condition it can be easily distributed on the soil by implements.

3. As already mentioned agricultural research went on from the very beginning parallel with the product research work, described in Section 2. Several products were prepared before we chose X_2 as the best one. All these products have been tested. The first quality of the product has relation to the suspensibility of the product. Adsorbed monovalent ions make the humus products, to a large extent, soluble. So we used percolation glass tubes, filled with a column of a soil sample diluted with fine quartz (1 part of soil and 2 parts quartz) covered with one of our products and sprinkled water over it. The suspension penetrates the column. Continued sprinkling dissolves the humus nearly quantitatively, so that the percolate can be analysed. Another experiment is to mix a soil sample with the humus in a household mixer and spray it with water during the mixing, until the sticky-point is almost attained. As a comparison an untreated sample is mixed and sprayed in the same way, the samples are put into a cylindrical flask with a wide glass-stopper and kept by thermostat control for two or three weeks, at about 27° C.

Then the samples are sprayed again with a very small quantity of water and the glass-stopper fastened. The flask is now rolled in a drum for two hours. The effect is that the treated soil forms a large quantity of small balls and the untreated, a small quantity of large balls. Fig. 5 gives an example.

With this "crumb experiment" we can test the reaction of the soil as well as the product, choosing a standard either of a defined product or of a defined soil. When measuring the balls by sieving over a set of decreasing sizes one can calculate the total surface and improvement of the soil-structure. What has happened is evident: with the treated soil the sticky point has risen in the moisture scale. Drying the balls one finds that at a lower moisture content the untreated balls are compact and difficult to press by hand, whereas the treated ones can easily be pressed into finer particles, because they are partially porous.

It goes without saying that most of our products are treated in this way and that we found the best results with X_2 . But there is in this experiment another essential point to mention, viz: by adding slight doses of X_2 and increasing them steadily, one reaches a dosage above which no further improvement is to be attained. This means that when the interior soil surface is covered with a very thin layer of X_2 the stickiness of the soil particles is diminished to the utmost value, whereas the X_2 molecules do not stick together. This "threshold value" lies at 0.075% to 0.15% of the weight of the dry soil, dependant upon the character of the soil (content of active particles and their composition). This brings the stable humus in the reach of practical application not only for market gardening, but also for wheat—and beet growers and other farmers, because the requirement of an acre for an arable soil-layer of ten inches lies between 3000 and 4000 lbs. per acre. The calculation of van Reesema shows that the cost per acre in Dutch money will be about 140 florins.

As to pot and field experiments we have to emphasize that X_2 is a

fertiliser, because of the exchangeable NH_4 as well as a soil-conditioner. The method of testing the N-fertilising can be best effected in potcultures, because with this method bad structures can be reliably reproduced. Filling pots with a soil, one has to use a refined soil and to mix this with the fertilizers. Watering after sowing is carried out by replacing the evaporated water every day, and in the Summer two or even three times a day, by putting in the centre of the pot a cylinder of pure quartz sand which reaches half the cylinder height, by providing this cylinder with a funnel, and by pouring water into it. The water (distilled) spreads homogeneously through the soil. Therefore the structure of the soil remains unaltered and most favourable to test a soil-conditioner. The result of hundreds of pot experiments is that with poor lime conditions the exchangeable N of X_2 is far better than sulphate of ammonia, of ammonia nitrate, and even of nitro-chalk. It is slightly better than sodium nitrate and with higher lime condition it equals those N-fertilisers or is better.

As pot cultures are not suitable for the purpose of examining the structure, we applied another method in the open field; small strips of about one to two yards wide and some 8 yards long, in our experimental garden, were dug about $\frac{1}{4}$ yard deep. These strips were filled with pure quartz sand up to 10 inches, from the soil surface. Upon the quartz sand, the soils to be examined were placed and left under atmospheric conditions. Some of these samples were afterwards partly treated with X_2 and others left untreated. The choice of the soils to be tested was directed by a thorough field-experience and later on we started field experiments on the plots from which we took the samples for the "garden research." The field plots measured about 15 by 15 yards and, where possible, larger. Samples were examined in the laboratory as described above. Beyond this we estimated the mechanical composition by the pipette method, the content of soil organic matter and the exchangeable bases. In one case we carried out a small plot experiment by varying the exchangeable Ca-content (lime status) by fixed amounts of exchangeable Na (4%), K (3%), Mg (4%); i.e. only the proportion Ca: H was varied in 8 ways. We give in the following table one of the most striking results with mustard.

TABLE 1		Grams of Seed		
		X_2	Amm. Nitrate	Sodium Nitrate
Plot 1	low lime status pH 5	415	155	195
" 2	" " " " 5.1	420	225	215
" 3	" " " " 5.35	410	285	250
" 4	" " " " 5.65	455	250	235
" 5	" " " " 6.50	460	295	310
" 6	" " " " 6.85	385	285	330
" 7	" " " " 6.8	370	340	400
" 8	high " " " 7.1	340	265	275

The application of X_2 is far the best, only with a high lime condition the production decreased. Fodder-beets on these plots gave an improvement of 25% in comparison with the nitrates, and likewise we found an increase of

crop weights in all our small plot experiments in the experimental garden. It is impossible to mention all the results of many years work in this paper, and space will now be given to explain what can be done with X_2 in customary farm practice. We must not forget, that whenever one succeeds in preparing a stable humus product which shows all the required properties in laboratory—or garden—experiments, it has only a theoretical value if the difficulties in practical application are more or less insurmountable.

Before we deal with this subject we have to mention that from all our garden and small field-experiments we took samples and made rather simple analyses, by drying these samples to a moisture content of about half the water capacity and sieving them over a set of sieves from 3 cm, 2 cm, 1 cm, and $3/10$ of a cm down to 1 mm and $\frac{1}{2}$ mm.

In fig. 6, we reproduce the result of one of our field-experiments on a large plot of a very sticky soil with 85% of the particles less than 2 micron.

The upper range of glass pots represents the sieve fractions of the treated soil, the set on which this range is placed contains the fractions of the untreated soil. The difference is evident and occurs principally in the size of clods more than 3 cm. and of finer material between 1 and $\frac{1}{2}$ mm.

The aggregates of all our samples were examined by making thin sections according to Kubinna¹, Redlich², from which one example is reproduced in fig. 3.

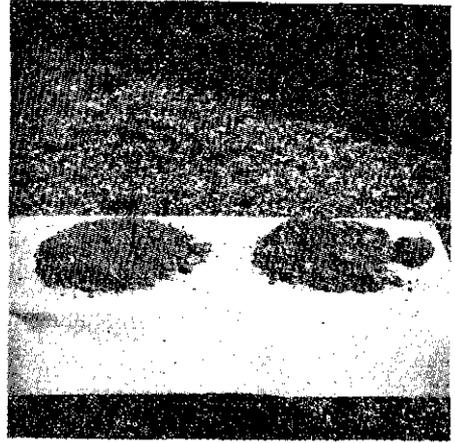
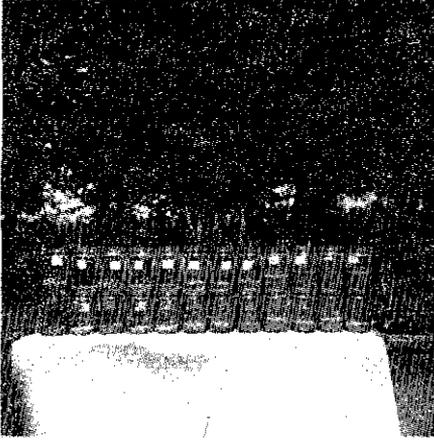
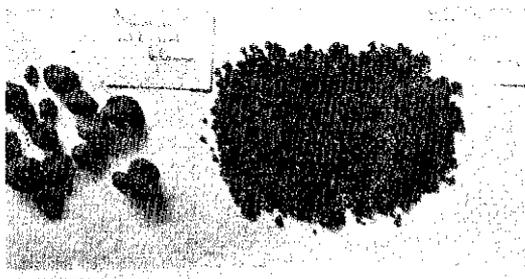
We gathered some hundreds of thin sections in order to study the process of crumb-forming from clods and found that this process begins at the clod surface, which by the effect of X_2 becomes porous and breaks off from the clod. Further penetration of the X_2 —suspension continues this disintegration process. But here we discovered a phenomenon which is very important for the practical application, viz. that when the compact aggregates are too big in size the X_2 suspension will not penetrate into them, but percolates down into the spaces between them or in crevices. It will be seen at the end of this paragraph how we solved this practical problem. In fig. 7 we illustrate an example of the difference between the treated and untreated soil.

It is evident that the first one is in considerably better condition. Fig. 8 shows the clods which remain from the 3 mm. sieve; on the left the treated, ~~one~~ on the right the untreated.

These fractions are isolated from 3 kg. of each sample. In order to determine if X_2 has any effect in the field, a hoe is used to feel the resistance of the top 2" of the surface. Workmen who are used to hoeing always feel these differences. Fig. 9 gives an example of this test.

In figs. 10 and 11 we give other illustrations of the improvement by X_2

It goes without saying that not all our experiments in the beginning gave as favourable results as we expected. Either the choice of the soils to be improved was not right or the X_2 was not the right material for the chosen type. As to the latter possibility we found that for some soils the proportion of the Al and Si-content in X_2 was not the right one. If the soil colloids have a high content of active SiO_2 (OH_2) in the organic complex, a soil-conditioner has to contain a higher Al-content. We can make the X_2 really inactive towards our



- Fig. 5 (top)—The crumb-test. Left, the untreated soil; right the treated.
- Fig. 6 (top, left)—Fractions from sieving on a set of sieves: Left to right, 3 cm, 2 cm, 1 cm, 8 mm, 6 mm, 5 mm, 4 mm, 3 mm, 2 mm, 1 mm, $\frac{1}{2}$ mm, and less than $\frac{1}{2}$ mm. Upper range of glass pots from a soil treated with X_2 and lower glass pots contain the fractions from the untreated plot. The greatest differences in fractions are above 3 cm and 1 to $\frac{1}{2}$ cm.
- Fig. 7 (top, right)—Soil samples from the upper layers of one of the experimental fields. Left—Sample of soil treated with X_2 . Right—Sample from untreated plot. (See also fig. 1.)
- Fig. 8 (bottom, left)—Clods larger than 3 cm. from soil samples of 3 kilograms. Left—from the treated soil; right—from the untreated plot. The same experimental field as fig. 5.
- Fig. 9 (bottom, right)—To examine if an X_2 treatment has had any effect, we test the surface layer by using a hoe to feel if there is any considerable resistance. Plots treated with X_2 show a loose crumbly structure of at least 2 inches, under which the scratched soil has a rough and dull surface. Untreated soils give a loose layer of $\frac{1}{4}$ —1 inch and by scratching deeper, a hard shiny surface.

standard soil sample by increasing the Al-content above a certain limit. As the SiO_2 is defined by the peat material, it depends on the Al-content of X_2 to obtain the maximum activity. X_2 is a dipole, so it is obvious, for exceptional cases the X_2 has to be prepared so that it is adequate for the soil type. Therefore before applying it, a crumb test is indispensable.

After the development of the preparation of the stable-humus, and of the controlling methods in the laboratory and in the experimental garden on small plots, we attacked the problem of the possibility of application of this rather expensive conditioner in the practice of farming and market gardening.

With our small plot field-experiments we met with several difficulties. First, the method of distributing the black powder uniformly over the soil surface. One can carry it out in calm weather, by sowing manually, but in doing so the soil-surface is covered by footmarks, which compress the soil and spoil the structure and later cause clods, on a stick soil, even when harrowing or hoeing follows. It is already mentioned above, that the soil-aggregates may not exceed a certain size. Therefore we can state emphatically that if a sticky soil cannot be worked even at an adequate moisture content, it is better not to apply X_2 . There is another essential point we found by experience, viz. the fact that we have to leave the conditioner in the upper layer, of maximum 2 inches. X_2 becomes less effective if you mix the estimated quantity into the whole arable layer of 10 inches. We find the same effect on the salt-soils, applying gypsum. This sulphate must be slowly dissolved by rainfall and percolate the upper layer exchanging the sodium from above down to the sub-soil.

In the beginning we spread the humus over the surface and disc harrowed it in at least to a depth of 6 inches. That was a mistake. Now we follow another method which is applied in practice on a large scale, on plots of at least one acre. We use the sowing implement of fig. 12, which is a construction of the "Rollia-mark," but as low as possible and provided with a protecting screen in order to be able to sow the black powder even during wind.

This sower distributes the fine powder most homogeneously and when a zig-zag harrow is towed behind it, the conditioner is mixed in the upper-layer and can by rainfall be suspended down to the lower-layers, coating in the meantime the soil particles to the threshold value and improving the structure. This process can be observed in the field, by the hoe-test and profile studies, and in the laboratory, by sampling clods and crumbs and examining them by the described methods. To estimate the porosity and the width of the pores, we used the method of putting crumbs and clods on glass filters with different permeability, according to *Sekara*⁴ and estimating the suction-tension.

Another test which is very convincing for the practical farmer is the raindrop-test. The apparatus is reproduced in figs. 13 and 14.

Drops falling from capillaries into Gooch crucibles, in which small aggregates are filled, will destroy the particles and block the perforations of the crucible. Moreover, untreated soils will be damaged sooner than the real crumbs of a treated soil. As the velocity of fall and the height of falling can be regulated, the stability can be expressed in these factors. The



Fig. 10 (top, left)
Soil samples showing a very evident improvement on a sticky heavy clay-soil. Left—the untreated soil, and right—the treated soil with X_2 in a quantity of 1.5% of the dry weight of the layer of 8 inches. From the Experimental Field—“Azewyn.”



Fig. 11 (top, right)
Soil samples from the Experimental Field—“Almkerk.” Left—treated with X_2 , 1.2% of the dry soil weight. Middle—treated with X_2 , 1% of the dry soil weight. Right—untreated plot.



Fig. 12 (left centre)
 X_2 Spreader with a load of 800kg. The black powder which blows easily with the wind, can now be spread even during wind. A harrow or zig-zag harrow can be towed after the spreader at the same time.

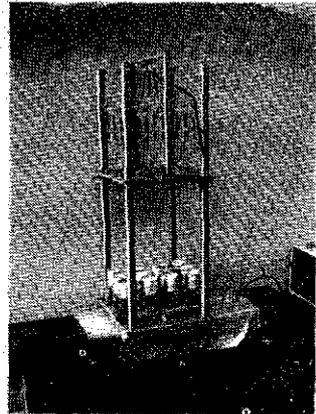


Fig. 13 (bottom, right)
Apparatus for the “rainfall-test.” The crucibles are filled with the soil aggregates. Drops fall from the capillaries which can be set higher or lower. The platform on which the crucibles are placed can be shaken by hand, in order to allow the drops to fall on different parts of the aggregates.

Fig. 14 (bottom, left)
The effect of the “rainfall-test.” Upper row of three crucibles filled with clod from an untreated plot, on which row the water lies. The lower set of three crucibles filled with the aggregates of a treated soil, into which the rainfall has percolated.

difference between the treated and untreated soils in fig. 14 is obvious.

Finally the crumb-structure can be destroyed at least by increasing the height and weight of the falling drops.

The larger scale experiments were carried out on long tracks, where the spreader could work up and down, at least 6 times. Where possible we chose a length of at least 200 yards. We left the treatment of the crop to the farmer, but under control. On the same field where X_2 was applied we pegged out an equal part of non treated soil, and took care that on both plots the same quality of fertilising plant-food was applied. During the growth we visited the experimental field at least once a week and in the Summer season, twice a week. The progress of growth, the development of soil-structure (improvement as well as retrogression) are documented by photographs and analysis. Thus we collect all data for the understanding of how the final crop is accomplished. If possible we estimate the weight of the crop in the whole. If the circumstances are not favourable to finish this in one day, we peg out several little plots, as large as possible and as many as possible, and they are weighed and sampled individually. We could not start such laborious experiments during the war. We started in 1949, and continued up to 1953 on several farms in our country. We found by former experience that beets are the most profitable plants to start with, because of the fact that the development in the very beginning of the germination defines, under normal atmospheric conditions, the yield. Thus we have the best experience with sugar and fodder-beets.

In figs. 15 and 16 we give illustrations of such an experiment.

Figs. 15 and 16 represent the crop just before harvesting, 15 the treated and fig. 16 the untreated plot. In this case the difference in yield was 25% calculated on the weight of the untreated. In the following table we give the result of our extensive field-work on different farms, spread over the country.

TABLE 2
Percentage increased yields over the untreated plots which received the same quantities of N, P and K

Sugarbeets, Elst. M.	25%
Sugarbeets, Elst. R.	20%
Sugarbeets, Y—2	20%
Fodderbeets Almk.	18%
Sugarbeets Y—N	20%
Fodderbeets Hank	17%
Sugarbeets Bab.	18%
Sugarbeets Oph.	17%

To estimate the after effect, the farmer has to take into consideration that he has to plough not deeper than 8—10 inches, because in our climate the effect of X_2 does not penetrate in summer-time deeper than 4 inches.

If the plough works deeper than 10 inches, the improved upper layer will be turned down and becomes a subsoil. The original unaltered subsoil is brought to the surface and becomes the new seedbed. So a subsoiler on this sticky clay soil is an indispensable implement. Because of this practical requirement we calculate the first quantity of X_2 to supply for the upper layer of about 5 inches, and repeat the applications the following year, when the plough has done its work in the indicated way. In this way, finally, a layer of about 10 inches gets a better structure and the deeper subsoil is loosened. Neglecting this instruction leads to failure. Examples with our own work in the very beginning and with the trials of others, who received good quantities of our X_2 , yet who had no experience, are at hand.

As to the after-effect, we had some good results, where the farmer followed our advice. Table 3 shows the after-effect data:—

After-effect, in percentage increased yields over the untreated plots, which received the same quantity of N, P, K as the treated ones.

TABLE 3
After-effect, in percentage increased yields over the untreated plots, which received the same quantity of N, P, K as the untreated ones.

Barley Elst M.	14 % (See fig. 16)
Maize (corn) Y2	20 %
Oats, Almk.	14 %
Flax, Y—N	20 %
Oats, Oph.	14 %
Wheat Y—N (second year after flax)	14 % (See figs. 17 and 18)

The advantages of the application are obvious: 20% additional crop of sugar beets and sugar (with increased sugar content sometimes) makes the return for X_2 in the first year, good. The after-effect is pure gain, not to speak

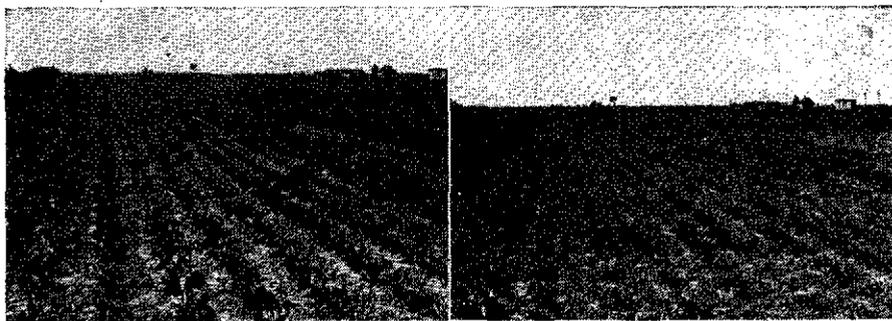


Fig. 15.

View of the treated plot of the experimental field Elst. No. 1. A favourable growth of sugar beets in May, 1949. Notice the "hollow" spots on the right.

Fig. 16.

View of the untreated plot of the experimental field of Elst. No. 5. A poor growth in May, 1949. Notice several "hollow" spots on the right.

of the economy of working a soil of good structure in comparison with a sticky one.

Fig. 19 represents an evident phenomenon observed in the wet summer of 1950.

We see on the left side a large plot treated with X_2 in 1949, where the barley stands and on the right side the untreated plot where the barley has been laid by heavy rainfall. Both plots received in 1950 the same fertilisers in the same quantity. Figs. 20 and 21 show the development of wheat in 1953, respectively, where in 1951 X_2 has been applied, and where not. In 1952 and 1953 the plots were equally fertilised.

As it is impossible to give a full record of 20 years research work with an enormous many-sided documentation, we only have given a general view of

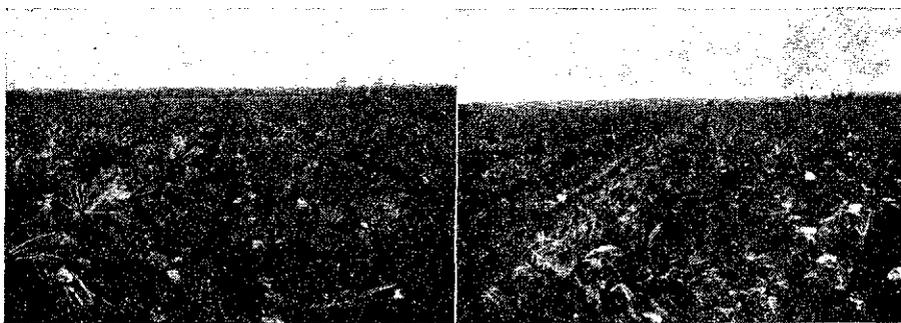


Fig. 17 represents the treated plot and fig. 18 the untreated.

Fig. 17.

View of the treated plot of the experimental field of Elst. No. 1, just before harvesting—yield 25% above the yield of the untreated plot calculated on the latter.

Fig. 18.

View of the untreated soil of the experimental field Elst. No. 1, just before harvesting.

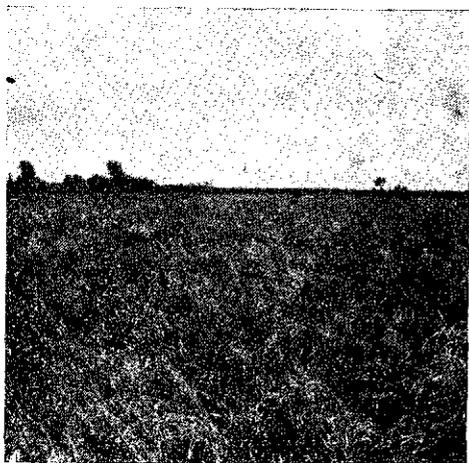


Fig. 19.

After-effect of X_2 on barley. Experimental field Elst. No. 1 in 1950. On left—the treated plot of 1949; the barley stands upright. On right—the untreated plot of 1949, where barley is laid by heavy rainfall in 1950.

the subject. We hope that those who have to meet with peat-problems will find in this summary an occasion to consider the possibility of using peat as a soil material for agricultural purposes. As soon as the agriculturists acknowledge the need for conditioning heavy soils and are of opinion that all ideas and attained experience are worthwhile examining, the peat-reserves will get a chance to contribute to prosperity.



Fig. 21.

The growth of wheat on the untreated plot of the Experimental field, M. Nord. A less favourable growth with "hollow spots."



Fig. 20.

After-effect on wheat in 1953, Experimental field, M. Nord. Plot where X_2 was applied in 1951 in a quantity of 0.9% of the dry soil for a layer of 8 inches. Favourable growth. Yield 14% above the untreated soil calculated on the latter.

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INTERNATIONAL PEAT SYMPOSIUM

Under the Auspices of Bord na Móna

SEPARAAT

DUBLIN, JULY 1954

SECTION F.2.

Reclamation — Agriculture and

Conditioning



X₂ AN ORGANIC SOIL CONDITIONER PREPARED FROM PEAT

by

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SUMMARY

SOIL CONDITIONING MEANS changing a heavy sticky soil structure into a crumbly fine porous structure which is easily worked.

When soils become wet and swell they reach a sticky, pasty point. For clay soils this sticky point is at a low moisture. Porous crumb aggregates have a much higher sticky point.

A study of this problem showed that repeated application of farm-yard manure, composts and town refuse acts favourably in ameliorating heavy soil structure, and in the long run this raises the sticky point considerably in the moisture scale. This method however is a long term one and expensive, so it was decided to attempt to make an artificial stable organic humus by chemical preparations of sphagnum peat. Peat moss being expensive, older black peat was chosen as the base.

By intermittent reduction and oxydation, with the application of oxygen and ammonia to the black peat in an exothermically heated autoclave, a reaction occurs for some hours, after which it ends, no more oxygen being absorbed. The reaction is controlled between pH 5.9 and pH 7.8. A little alumina in the form of alsulphate is added in a certain proportion to the natural SiO₂ content of the peat.

The product known as X₂ is a fertiliser as well as a soil conditioner, and extensive tests over many years in pot and field experiments showed increases in crop yields of up to 25% by weight.

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SOIL conditioning means ameliorating a bad soil structure of a sticky soil, which consists of compact granules or even clods of large size and which is heavy to work when the soil is wet and impossible to work when dry, into a layer of fine porous crumbs, which do not stick together and which is easy to work. The structure of a soil depends on the " texture " and on the chemical and physical properties of the composing particles. The texture is defined by the size of the particles, their quantitative distribution in the system and their arrangement. As we are concerned, in this paper, with soils which have a high proportion of particles of less than 2 microns, we have first to consider the chemical and physical properties of this fraction. Heavy clay soils consist of 40 to 90% of such small pieces. Chemically, we must take