

The Practice and Principles of Green Manuring.—Contd.

You will see therefore that we have these different types of crop. We have the long growing crop and the crop that matures in a very short while, but I still think we might improve on getting a suitable winter crop provided we can get suitable seed.

There is another paragraph I would like to read out to you in regard to the nitrogen supply of the soil. We know at present it does not affect South African conditions in general but this is an extract from an American Bulletin:—

“Except on those soils which still have a large proportion of unexhausted nitrogen left, the nitrogen problem is a most important soil fertility problem before the farmer. . . . Legumes and green manures are needed in larger degrees . . .”

You will see we are ever facing problems and trying to solve these different problems. I have tried to show you briefly the importance of organic matter or green manuring in the soil. In conclusion I would like to add this: As a means of restoring the humus content of the soil, as a means of lessening soil erosion, and as a means of getting the best value out of the artificial fertilisers, green manuring may help you to gain the goal. In other words, I would like to say that the success of any farming depends on no factor more than the maintenance of the soil fertility and without humus you can never maintain the soil fertility. (Loud applause).

The Chairman on behalf of the members expressed their appreciation of Mr. Edelman's address.

GREEN MANURING FOR SUGAR CANE.

(Paper by H. H. DODDS, Director of Experiment Station, Natal.)

It is evident that the main agricultural problem in nearly all the older sugar growing countries is the progressive exhaustion of the organic matter, or so-called humus, in the soil, and many parts of Natal also appear to have reached this stage. Records of soil analyses and comparative yields of cane in the early days are lacking, but I believe that many old colonists will agree with me when I suggest that the soil in Natal, like the old grey mare in the song “ain't what it used to be, twenty long years ago.” However that may be, there is no doubt that the records of soil analyses from different parts of the province show that in the older sugar growing districts and even in many of the new ones there is now a marked deficiency of organic matter in the soil.

Insufficient attention has been given to this essential factor in the past. On the more scientifically conducted estates commercial fertilizers have been systematically applied for years, together with sugar house waste products rich in the required lime, so that the soils in these cases are not usually conspicuously lacking in other plant food ingredients in an available form, but in nearly every case they are deficient in humus. On very few estates has any attention been paid to the cultivation of green manure crops as a source of humus, and that only within the last two or three years. This deficiency in organic matter is still more marked in other parts of the province where cultivation has been less intensive and where the practice of burning the trash from the cane has been systematically followed.

To restore and maintain the fertility of the soil I believe it will be necessary to institute the practice of green manuring as an essential part of our system of agriculture. Unfortunately it has not

been to anyone's direct pecuniary benefit to any considerable extent, except to the planter himself, that green manure crops should be grown, hence the vigorous and effective propaganda which has been devoted to the sale of some other of his raw materials has hitherto been lacking in this instance.

In the sugar growing districts of Louisiana the exhaustion of the fertility of the soil after long continued heavy cropping reached an acute stage a few years ago. The yield of cane per acre has steadily fallen during the past few years from 18 tons per acre per annum in 1921 to 7 tons in 1924.

Several causes are contributory to this decline including mosaic disease, various insect pests and unfavourable seasons, but in the opinion of those who are in the best position to judge the principal cause is the decrease of permanent fertility. Some years ago second and third ratoon crops were commonly grown, now one ratoon crop is the most that will give satisfactory returns and even this usually shows a marked decline in yield compared with the plant cane.

The rotation which came into general use was two years of cane comprising plant and first ratoon crops, followed by a rotation crop of maize, the residues (stalks, etc.) of which were ploughed in as early as possible and succeeded by a green manure crop of cowpeas which was ploughed in before planting cane for the following season. This practice certainly postponed the day of reckoning for a time, but it soon became evident that the progress of soil exhaustion had only been checked and not stopped even though commercial fertilizers were extensively used.

Looked at from the point of view of the nitrogen balance which is a convenient rough method of estimating the fertility of the soil arithmetically,

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136 lbs. of nitrogen per acre were required for the growth of the two crops of cane and at most only 78 lbs. of nitrogen can be supplied by the cowpea crop, so that there is a net loss represented by 58 lbs. of nitrogen in the rotation, without taking into account the loss in nitrogen in the grain and cobs of the maize which may amount to 34 lbs. per acre with a 25 bushel yield. It was not considered practicable on most estates to devote another year to fallow with a second crop of cowpeas or other green manure.

The problem is analyzed very clearly in several of the annual reports of the Committee on Agricultural Progress of the American Sugar Cane League, especially in 1922 and 1923.

Eventually a method was discovered at the Louisiana Sugar Experiment Station of introducing another green manure crop into the rotation without extending the cycle and with very beneficial results.

The usual practice in Louisiana is to plant cane in October, when it remains dormant in the soil throughout the winter, and begins to grow in the following spring. Several winter growing clovers and other plants were tried and it was found that *melilotus indicus*, a melilot known as yellow sweet clover, was of the greatest value. It was planted on the cane in October and when ploughed in preparatory to cultivation of the cane in the spring it was found to add 10 to 13 tons of greenstuff per acre which contained nearly two tons of humus, and over 100 lbs. of nitrogen, equivalent to nearly 700 lbs. of sodium nitrate costing about £11 (without the humus).

The average sugar cane yield in the experiments was over 14 tons per acre compared with less than 10 tons from adjoining control plots, an increase in value of about £5 per acre directly due to the green manure at a cost of not more than 14/-.

Not only this, but the exhaustion of soil fertility had been checked and the balance restored.

Similar increases were found on plantations where the method was given further trial on a larger scale. The benefit to Louisiana is incalculable since it is not too much to say that this practice will save the industry in that State.

Further details will be found in Louisiana Bulletin No. 189 by W. G. Taggart, and in recent annual reports of the Louisiana Experiment Station. This instance has been described in some detail as a remarkable example of the benefits of green manuring for sugar cane. In other highly developed cane growing countries such as Mauritius, Queensland and others, green manuring has long been practised and even in those countries where less intensive methods are still practicable, as in Cuba, it is coming into use. In South Africa the need is likely soon to become urgent, the descent into the abyss of infertility is likely to be the more rapid here in view of the wasteful methods of cane cultivation,

such as the practice of burning the trash, the erosion of surface soil which frequently occurs in heavy rains and the natural lack of phosphate and alkalinity in the soil.

The difficulty of devising a suitable scheme of applying green manures in this country is great in view of the prolonged ratooning periods, for which it is not easy to suggest practical methods of green manuring. Much, however, could be done with land which is due for replanting with cane, and a year's fallow could very profitably be employed in growing a succession of green manure crops appropriate to the different seasons of the year.

The discovery of the best crops to grow for this purpose is one of the most important tasks before the experiment station, and several trials in different localities have been begun this year.

Green manure crops may be classified into legumes and non-legumes. It has been observed since very early times that certain crops in many cases appeared to enrich the soil instead of impoverishing it; but the reasons for this fact have only been understood within recent years. One striking example of the benefits of green manuring was shown in 1880 when Schultz in East Prussia converted some barren sandy heath lands into fertile soils by growing lupins.

In Britain green manuring is not practised very extensively. In the systems of mixed farming in use there, usually in connection with a highly developed stock-raising industry, it is generally preferable to feed crops to stock and return the manure to the soil instead of turning the crop into the soil. But even there, according to Sir John Russell, of the Rothamsted Experiment Station, a greater use of green manuring would be advisable, and the quantity of humus returned to the soil should not be limited by the number of animals the farmer finds it convenient to keep.

The legumes are usually the more highly recommended for green manuring since they have the property of harbouring certain bacilli in their root system which can absorb nitrogen from the atmosphere and fix it in the plant so that it eventually enriches the soil. This factor is naturally of paramount importance where nitrogen is the dominant fertilizer requirement, which is the case in the cane sugar industry almost everywhere. In South Africa, however, there is evidence to show that conditions are rather unique in this respect, as in others.

Although the nitrogen content is seldom very high, it is not very low even after exhaustive cropping providing that there is sufficient organic matter present. In fact, it has been found, as Mr. Blewett will tell you, that the proportion of nitrogen in the organic matter of soils from similar areas remains remarkably constant even after much nitrogen has been withdrawn by a growing crop. Like the widow's cruse of oil, the small amount of nitrogen never seems to fail and I believe this is one

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reason why commercial mineral fertilizers supplying nitrogen only are usually found unprofitable when supplied alone, or even when mixed with a phosphatic fertilizer or in a general mixed fertilizer beyond relatively small quantities of the nitrogenous ingredient.

Besides the bacteria mentioned above, which can only flourish on the root nodules of leguminous plants, there are other bacteria in the soil (known as azotobacter) which also have the function of absorbing nitrogen directly from the air and do not live in plant roots. They require a sufficiency of organic matter in the soil and neutral conditions (neither strongly acid nor alkaline)—incidentally invert sugar is one of the best kinds of food for them, hence the special benefit of applying molasses and filter press cake to the soil. Although these bacteria cannot fix as much nitrogen as the root bacilli of the legumes, it would appear that soil conditions in this country are usually very favourable for their activity, if they are provided with sufficient organic matter. I am inclined to believe that in many of our soils if we take care of the humus, the nitrogen will take care of itself. Consequently non-leguminous green manure crops are likely to be very useful in this country even though they do not directly contribute nitrogen from the air. If so, this is very fortunate since many of them will flourish in lack of moisture and other unfavourable conditions such as most legume crops would not tolerate. Some of them also make more rapid growth than legumes.

Some brief notes on the plants which may possibly be grown for green manuring may now be given.

Velvet beans (genus *Stizolobium* formerly *Mucuna*). This is generally believed to be the best of all the commonly used legumes for green manuring but requires a well drained non-acid soil with sufficient available phosphate; it is sensitive to frost.

It is very free from disease or insect pests and is immune or very highly resistant to eelworm and wilt which are very liable to affect certain varieties of cowpea. About 20 varieties are known and many hybrids. Owing to its climbing habit it is frequently cultivated in combination with an upright crop for its support. In America maize is sometimes used for this purpose; sunflowers may also be used or in old cane lands a few cane stools may be left standing to support the beans.

The amount of seed used is about 50 lbs. per acre and the time taken to grow to the flowering stage, which is usually the best time to plough it in, is about four months under Natal conditions.

In the block which was to have been observed this morning a yield of 9.6 tons per acre was obtained which represents 1.32 tons of organic matter containing 73 lbs. of nitrogen, equivalent to the nitrogen in over 500 lbs. of sodium nitrate. This season has, however, of course, been unusually favourable

hitherto for the growth of a green manure crop such as this.

Mauritius Bean or Black Bean (*S. termitum*) is another species of the same genus which is also a very useful green manure plant.

Cowpea (*Vigna* spp.)—This may be described as a general utility leguminous green manure crop, being grown for this purpose in sugar cultivation more than any other crop. While it is usually not quite so luxuriant as velvet beans it is more adaptable to a greater variety of soils, although it flourishes best in sandy soils or sandy loams and should be well provided with lime.

As in the case of most legumes it is best to fertilize with phosphatic and potassic fertilizers on poor soils.

Cowpeas are indigenous to Africa. There are 15 common and well defined varieties and many other strains of mixed origin or known only in certain localities. Certain varieties such as Brabham, Iron, and others are known to be resistant to wilt and eelworm (root knot) to which most of the varieties are susceptible. If the seeds are to be stored for any length of time, it is advisable to fumigate them with carbon disulphide or hydrocyanic acid to destroy weevils; they are very subject to the attacks of these insects. Under favourable conditions cowpeas will yield organic matter containing 60 to 80 lbs. of nitrogen per acre.

Mung Bean (*Phaseolus aureus*).—This is a plant of Indian origin which is an excellent green manure crop. It is of erect habit and consequently can be more easily ploughed in than either velvet beans or cowpeas. It gave a rapid and luxuriant growth at the Louisiana Sugar Experiment Station but was found very liable to be eaten off by caterpillars.

It has done very well in the co-operative experiments at Chaka's Kraal and Empangeni this season, but a small quantity recently tried at Umbogintwini was attacked by some root fungus.

Sunn Hemp (*Crotalaria juncea*).—This legume appears to have been comparatively little grown for green manuring, but obviously has great possibilities in this direction. It has made very tall and rapid growth in very poor sandy soil at Umbogintwini. It is a very fibrous plant and has been grown in India as a source of fibre. For use as a green manure probably it would be better to plough in after it has attained a height of about 3 ft. in order that decomposition may be sufficiently rapid. The seed which is difficult to obtain locally at the present time should be applied at the rate of about 40 lbs. per acre.

Yellow Sweet Clover (*Melilotus indicus*).—This plant which as mentioned did so remarkably well in Louisiana unfortunately has uniformly failed hitherto wherever it has been tried on the Natal Coast, in common I understand with other clovers. Apparently it only flourishes in localities having winter rains.

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Lupins (genus *Lupinus*)—As mentioned these have done very well on poor sandy soils elsewhere, but there has been no opportunity of obtaining sufficient seed locally for experiment up to the present.

All of the above legumes excepting the two last named have been found to form freely the root nodules which harbour the nitrogen fixing bacilli. There are many proprietary cultures of these bacilli for various types of legumes on the market, for which wide claims are sometimes made. However, in the event of any ascertained deficiency of nitrogen nodules it is simple and effective to scatter a little soil (air-dried in the shade) from some field which has been growing a similar crop. A kind of swelling or gall on the root fibres caused by eelworm, (a nematode worm which affects certain legumes such as many varieties of cow pea) is liable to be mistaken for the nitrogenous root nodules. However the interior of these galls are white until they have destroyed the root when they decompose turning brown, whereas the interior of the nitrogen nodules is a more or less greenish tinge. Under a low power lens or magnifying glass the female eelworm may be distinguished in the former as a small pearly white, pear shaped body about the size of a pinhead. The best remedy is to use only immune varieties until the pest is starved out of infected fields.

Buckwheat (*Fagopyrum* Spp.)—This appears to be the best so far of the few non-legumes that have been tried in Natal as a green manure. It will grow on almost any soil that is not waterlogged and will do well on poor sandy soil deficient in moisture although it responds to good conditions. It has done well planted very early in the season during very scanty rainfall which leads one to hope that it may make some growth during the driest months. It grows rapidly so that it may be ploughed in, five or six weeks after sowing. The seed should be broadcasted at about 40 lbs. per acre. At present seed is plentiful and cheap locally.

Buckwheat appears to be little affected by diseases or insect pests. It is a good bee plant, as the flowers yield excellent honey.

Rape is another quick growing non-legume that has been recommended as a green manure crop. The preliminary trials with it have not been very successful, but were both on unfavourable soils; one a poor sandy soil at Umbogintwini, and another on a waterlogged clay at Empangeni. It is proposed to give it a further trial on a somewhat better sandy soil at Tinley Manor.

Mustard, oats, and rye are also non-legume crops which are worthy of trial under suitable conditions

as green manures, but as far as I am aware have not yet been used for this purpose on the Natal Coast.

It is perhaps somewhat premature to indicate after so little experiment any system of green manuring but it would appear to be a promising course, after ploughing and harrowing the old ratoon stools, to sow broadcast a crop of buckwheat if the cane has been cut early in the season. This could be ploughed in after about six weeks or so and followed by a crop of velvet beans, cowpeas or other legume according to the kind of soil. By this time the weather would be sufficiently warm and moist to ensure rapid growth of the legume. After ploughing in the legume, possibly another crop of buckwheat could be obtained before the dry weather had set in. In this way three green manure crops could be obtained before it was time to replant with cane.

In case of late harvested cane the first crop of buckwheat would have to be omitted.

Lime and fertilizer should be applied as early as possible in the rotation, so that the benefit would be available to each crop in turn.

After a green manure crop has been ploughed in, no other crop should be planted for two or three weeks in order to give the green manure time to decompose in the soil.

The quantity of humus and nitrogen actually added to the soil by even a heavy green crop is small, compared with the total amount already present even in the poorest soils.

Thus, assuming the weight of an acre of land to a depth of 1 foot to be 1,500 tons, a very low organic content such as 1.5 per cent represents 22 tons per acre, whereas as we have seen a heavy green manure crop will only contribute 2 tons of dry organic matter per acre. Probably some of the actual benefit derived must be attributed to other effects of the green manure crops, possibly an increase in the number and activity of the bacterial flora of the soil.

Our hosts, Natal Estates, Ltd., are to be congratulated on being in the matter of green manuring as in other respects in the forefront of scientific progress in the sugar industry of this country.

I would like to take this opportunity to say how much I appreciated Mr. Soutter's remarks regarding the need for united effort in the sugar industry. Mr. Blewett suggested yesterday an excellent slogan of "30 tons of cane per acre." That is very good as far as it goes, but I do not think it goes far enough.

The end and aim of the sugar industry is not only to grow cane but to produce sugar, and I believe that our immediate aim even with our two year crop ought to be "two tons of sugar per acre per annum" and with united effort we can do it.

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At the conclusion of Mr. Dodds' paper the Chairman said:—

"We have had two lecturers who have shown us that we don't know how to grow cane, and I must admit there is a good deal at the bottom of it. I think the Natal men all these years have been on the right track with their trashing, otherwise they could not have expected to grow cane for fifty years on the same ground. Of course I know we don't all hold the same ideas in Zululand, but we are living on our capital I am afraid and we are going

to pay for it bye and bye (hear, hear). There is no question about that. It is not a personal opinion, it is a fact. These gentlemen have shown you in how many ways you could find a green manuring crop to suit any condition of climate, time of the year and soil. We have not much time left to-day and as the majority of the questions you would ask are on the agenda for to-morrow you can ask all the questions you like to-morrow. I will just ask you to join me in a vote of thanks to Mr. Edelman and Mr. Dodds for the very interesting and enlightening papers they have given us (loud applause).

APPROXIMATE METHODS OF FARM SURVEYING.

(Address by T. A. WARNER, Government Land Surveyor.)

It seems a very far call from green manuring papers to one on such a different subject as surveying, but from remarks which were passed at lunch I think it was brought home to us how necessary it is to get a little more accurate data in connection with the work which we do, not only in our factories, but also on our farms, so that we can get comparative results and know from the financial point of view whether it pays us to do certain experiments which may appear to our scientific friends to be very nice. We want fairly accurate figures as to whether they really pay or not.

From the farmer's point of view the first problem he is faced with is the one of being able to accurately lay off his farm and know the area of his fields. This particularly applies to sugar, where you have comparatively speaking a crop of great value per acre, probably more so than most other crops, and so from the sugar planter's point of view this matter is rather important.

There is another aspect of the problem, and it is really one of the reasons that has tempted me to inflict you with this address to-day. In my professional experience I have unfortunately lately come across quite a number of cases of rather serious disputes between buyers and sellers of farms as to the acreage of the cane existing on their farms. At the present time I am interested in two cases which I am afraid will go to the Supreme Court and you know what that means. I am quite satisfied in my own mind that in none of these cases has there been any deliberate attempt on either side not to give accurate figures. The position has been that the people have not sufficient knowledge to really know what acreage they had. They thought they had it but they find they had not. I don't want you to think that I am going to give a talk on surveying so as to pass Government standards for purposes of transfer, but if I can show you a simple

way by which an ordinary person of average intelligence can measure up his fields to within a reasonable amount I hope that will be of some value to you (hear, hear).

Fortunately on the coast of Natal our lands are not very highly mineralised particularly with regard to iron, and therefore we are able to make full use or could make full use of the prismatic compass. Many people bring me problems and ask me to give them the area of their fields, and they give a whole lot of measurements and ask me to tell them what the area is. Now that is a physical impossibility for anybody to do and I think where the average person goes wrong is that they put a great amount of stress on to the actual measurements, that is to say the lineal measurement, without taking any account of the angular measurements; the one is just as important as the other.

We should try to retain our unit of measurement and that is the link. In towns and places where a lot of building has to be done gradually the foot method of measurement has ousted the link, but people to-day are beginning to think a good deal more than they did with regard to link measurement; it is the one little bit of decent decimal unit that we have in the whole of the British standard of Weights and Measures. It is very simple and easy and I cannot understand why it is not used more than it is.

There are 100 links in a chain, the equivalent of which is 66 feet. The advantage is that there are 100,000 square links in an acre. If you are measuring up a field and you can reduce it to a parallelogram it is quite simple. In links 500 by 200 equals 1 acre; 600 by 400 equals 2.4 acres, etc. I will give you a few examples (demonstrates on blackboard). There is only one figure of which you can get an accurate area by linear measurement and that is from the triangle. On level ground as in the Orange Free State and Transvaal fields are gen-