

MONOCULTURAL PRACTICES WITH SPECIAL REFERENCE TO SUGAR-CANE PRODUCTION

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When I received the kind invitation of your Association to attend your Congress, I accepted it with a great deal of trepidation. My knowledge of sugar production is so fragmentary that I felt it somewhat presumptive of me to accept the honour of opening the agricultural session.

I look upon sugar as one of the most important foods of the world and its production as one of the most vital cogs in world economy. The health, happiness and prosperity of our Western civilisation probably depends more on sugar than on any other single product of the soil. I was greatly perturbed, therefore, by the scathing denunciation of sugarcane monoculture and its attendant chronic starvation by de Castro in his excellent and authoritative review of world food in "Geography of Hunger." He states amongst others: The colonial system of soil utilisation and land tenure contains the germ of that defective economic organisation which has brought the human groups of the area (Central America) to their present precarious situation. The product chosen as the basis of the economical exploitation of the region—sugarcane—also has a decisive effect on the future of these people. . . . Now it happens that sugarcane is the sort of product that most encourage exclusive monoculture, great plantations and even the practice of absenteeism in which capitalists merely finance the monopolistic enterprise, without ever appearing on the scene. Such an economic situation soon developed in most of the Antilles which were devoted almost exclusively to the cultivation of this plant with its evil individualism and its almost morbid hostility to other vegetable species. It is an extremely demanding plant; it forces soil and human beings into slavery because only in a regime of total slavery can the sugarcane economy show a profit . . . American sugar, then, was a goodly inheritance for the colonizing countries; but the countries that were colonised received only undernourishment and starvation as their share. It is one crop sugar farming that is responsible, in spite of relatively fertile soil and a climate favourable to agriculture, for the chronic starvation of the peoples of the West Indies."

I can only trust that Dr. de Castro is referring more to the past than the present and to the West Indies only, not to Natal; I hasten to express my sincere conviction that, although it may have many sins to atone for, our sugar industry in Natal carries its own complete vindication in its record of service and of intrinsic value to South Africa over the past half century.

In any case, it is not for me to cross swords with Dr. de Castro on your behalf, but at this, being an agricultural session, I would like to discuss briefly some of the points raised in the above quotation, which I believe is based on a serious misconception of the true nature of a monoculture and its effect on the soil. I need hardly mention the relevance to sugarcane production, but as mentioned above I make no pretence to any knowledge of this crop; I believe, however, that in general the principles involved in regard to the influence of the sugarcane plant in the soil are the same as those that apply to the ordinary farm crops and grasses, with which I am better acquainted.

The question that interests me for the present is whether the sugarcane is such a demanding plant; *by virtue of its monocultural nature*, that it forces both soil and humans into slavery.

Now all systems of monoculture have been condemned from the beginnings of intelligent agriculture, and no doubt practical experience over many years and under a wide variety of conditions has consistently lent support to this condemnation. In our maize triangle monoculture of meales stands accused of creating the same dust bowl conditions that resulted from wheat in the U.S.A., and we are told that, thanks to the exhausting monoculture practised in the South (of America) the greatest stripping of top soil seen anywhere in the world has taken place and enormous areas have been rendered sterile by erosion.

These are the facts; but I have never been greatly impressed by the reasons given why monoculture should be so viciously exhaustive of the soil—to the economic and human aspects I will return later. In fact I have often had occasion to express the view that if I were a farmer in the maize triangle I would be sorely tempted to practise maize monoculture as long as it pays me, without feeling that I am committing a crime against the soil.

Monoculture in Nature

When one goes back to nature, as one is so often adjured to do, one finds a natural system in the nature of an absolute monoculture in the climax grass association of the veld; a system in stable equilibrium with its environment, and in which the soil is permanently maintained at a certain level of productivity. It may be objected that the veld consists of a variety of plants, not of one species, which is the essence of a monoculture; but it is the

same plants that the soil has to deal with year after year, and apart from the perenniality of the veld species it would be strictly comparable to scattered micro-plots in which maize, sorghums, millets, etc., are grown in monoculture adjacent to one another and each one, every year, on its own plot. Moreover there is no reason to believe that a pure stand of a given perennial grass, and thus fully monocultural in character, will in any way be less able to maintain the soil than the natural veld vegetation.

The remedy prescribed for the disastrous results of monoculture is a rotation of crops; but why should (say four) annual crops grown in sequence be less exhaustive, for the same production of digestible nutrients, than any one grown continuously?

Economic and disease factors naturally come into play here but it seems to me that we are placing the emphasis entirely wrongly by blaming soil exhaustion, erosion and the other evils of modern commercial agriculture on the fact of monoculture.

A perennial monoculture is nature's rule which we violate not by practising monoculture as such, but by the fact that we break the perennial character of the soil cover. It is only to the extent that root growth in the soil is destroyed or interfered with that damage to the soil can result. It is the repeated destruction of roots every year under annual cropping that leads to soil exhaustion and erosion, whether this is done in monoculture or in a rotation of annual crops. The exhaustion results from the loss of organic matter which takes place as soon as the retarding influence of the growing roots, on the mineralisation of soil nitrogen, is no longer operative, as happens for the greater part of the year under annual crops.

The soil is an organised and extremely complex system in dynamic equilibrium, resulting from the interaction of two opposing forces, namely the forces of weathering, continually tending to break down and simplify the substrate on the one hand, and the constructive action of plants gathering energy by photosynthetic activity on the other. In nature a balance is established in time between these two forces and it is this that we disturb when the natural vegetation is destroyed by ploughing and cropping; and no less so by over-grazing.

The Plant Factor

The plant protects and builds up the soil in various ways; protects it against erosion, against acidification by curbing leaching and the loss of bases, but probably its main influence is exerted in that it establishes a control over the activity of the micro-organisms which are responsible for the mineralisation of its organic nitrogen components, and by this action it automatically controls the loss of humus. How the plant exerts this action is not clear, but it

is obviously intimately associated with the transfer of carbohydrates from the leaves to the roots, and can therefore only be exercised effectively by perennial plants, and only if these are given the opportunity to gather carbon to transfer in sufficient quantities to the roots. Over-grazing, for example, by continually removing leaves, and thereby the reserves of carbohydrates, will naturally prevent this action.

When the natural vegetation is destroyed by ploughing the counter-balancing force on which the balance of nature depends is removed and the forces of weathering can proceed unchecked. Destruction takes place in many directions, but of greatest interest for the present and the effect most readily observed, is the destruction of accumulated organic matter since microbial activity is now left to proceed uncurbed. The consequent deterioration of soil structure results in defective crumb structure and moisture absorption, and ultimately in the denudation of the surface by erosion and blowing.

The Animal Factor

Under perennial crops, on the other hand, the loss of humus is prevented once the plants are properly established in the soil. In respect of these crops the introduction of the animal factor so frequently advocated by our soil conservationists—even as regards the sugar belt—would seem entirely redundant, and it may in fact be deleterious if excessive defoliation is allowed. In a sense this is true even for annual cropping; the animal is not essential if humus is replenished from time to time under a fertilised perennial grass, and rehabilitation is effected much more rapidly if the grass is left to grow undisturbed and not cut or grazed.

Our views on diversification in farming and the necessity of the animal in the maintenance of soil fertility, have undergone a fundamental change in recent years as a result of a clearer comprehension of the nitrogen relationships in the soil, and the important influence of plants on these relationships. The animal is by no means a producer but a consumer of the all-important soil humus. It does not produce any organic matter and it seems highly unlikely that it can add anything of value. What it does do is to accelerate the mineralisation of organic matter, but from the point of view of humus conservation it can add nothing.

Conservation of Humus

The only practical means of maintaining the soil and its humus content in general farming practice, is to "rest" the soil from cultivation, under a perennial grass ley and the necessity of fertilising the grass with a nitrogenous fertiliser is strikingly evident in practice. In our grain producing areas

effective and profitable utilisation of the very expensive ley—in view of the cost of nitrogenous fertilisers—is a problem still bristling with difficulties; intensive utilisation may result in a loss of humus instead of a build-up, due to the severe and continued defoliation; whereas under-utilisation of the ley crop may result in a severe immobilisation of the nitrogen when the soil is ploughed again.

The sugar planter is spared most if not all these problems. Sugarcane would appear to be the ideal crop to conserve humus, loss of which can take place under this crop only during the period that the new crop is being established. This loss is easily replenished during the period of the ratoons, since cutting takes place at such infrequent intervals that the plants are given ample opportunity to transfer organic matter to the roots and the soil.

As mentioned above, my knowledge of sugarcane is so fragmentary that I am treading on dangerous ground, but to all appearance this crop reacts, in every way, analogous to the ordinary grass leys with which I am better acquainted. Thus the marked response I have seen of plant cane, to applications of phosphates—I believe this to be fairly general—is similar to the reaction obtained with newly-established pastures, and is a clear indication of nitrogen liberation and humus loss during the period of establishment. The response to nitrogen of the ratoon cane, again, shows that nitrification and humus mineralisation is effectively inhibited and thus humus regeneration can take place under the ratoon crop.

In view of these observations, one is very dubious about the efficacy and value of the trash left in the surface after a cutting, that is, its value and efficacy as a source of humus. As such it is really redundant. The trash probably has other merits and the conservation of plant nutrients, especially nitrogen liberated to the soil on decomposition, must in itself be a strong recommendation for this practice, but as a measure to maintain humus the trash can play but a very minor and unessential role.

The Human Potential

As far then as the soil and its conservation is concerned, one can find no good reason why sugarcane monoculture should not be practised. With the assistance of fertilisers, particularly nitrogenous fertilisers, the humus content and the fertility of the soil should be effectively maintained; and with the application of ordinary good farming practices, cultivation on the contour, etc., it should be possible to confine mechanical loss of soil to a minimum notwithstanding the uneven topography.

I believe this to be true even for a monoculture with annual crops provided the necessary precautions are taken to regenerate humus and maintain the soil structure under some ley crop.

To what extent, however, is a monocultural system of farming destructive of the human potential? Is its individualism evil, if not necessarily in respect of soil exhaustion, then in respect of the human beings who happen to be associated with its culture? Assuming a fair measure of goodwill in our human relationships, I can see no *a priori* reason why a monoculture should necessarily be exhaustive of the human potential, but it undoubtedly contains the germ of such an evil, a germ that can readily flare up under a defective economic organisation.

I still like to think of farming as a way of life and not as a business proposition, and although one cannot avoid altogether introducing business principles in our farming, I think it will be a sad day when farming is done on purely business lines. And how readily a monoculture of any or all types, lends itself to the machinations of big finance and the dictates of managing directors whose roots are anywhere but in the soil.

In this connection I am thinking more particularly of the many specialist agriculture institutions that have been created recently and others in the making, institutions serving, probably with great efficiency, some crop or other that happens to have a statutory board of control to protect its particular monocultural interests and guide its destinies smoothly along a monocultural groove.

In the case of the sugar industry one can still find ample justification for the specialist experiment station since one is concerned here with a crop that can be grown by itself, that demands very specific climatic conditions and is geographically confined to a narrow strip along the coast of Natal.

Similar arguments, albeit with less force, may be advanced in favour of citrus and other perennial cultures; but are such institutions in respect of annual crops such as tobacco, maize, potatoes, etc., which cannot possibly be grown solely in any system of farming one can visualise to-day, to be fitted into the framework of a sound rural economy, of farming as a way of life?

In the tendency of practically every one of our commodity Boards to establish their own extension and advisory services and monocultural research institutions, I seem to see developing just that "evil individualism" of which Dr. de Castro speaks; an individualism which may well become the Frankenstein creation of our rural life.

To those who encourage and applaud this tendency on the grounds of efficiency, I would say in the words of Charles E. Kellogg: "Although the concentration of skills may bring efficiency of production it hardly leads to democracy, at least not the kind of democracy people have known before," and I would add, not the kind of democracy I would like to see grow in rural South Africa.

The President, in introducing Prof. Theron, thanked the University of Pretoria authorities for allowing him to come and stated that the sugar industry benefitted tremendously by having outside expert advice. He stated that Prof. Theron had given us a new way of looking at our particular problems, trash, animal factors and the like.

Dr. McMartin stated that Prof. Theron had stated some things which were long overdue. He said that some agriculturists in South Africa considered that we were mismanaging our farming in the sugar belt by monoculture of cane. He was very glad therefore that Prof. Theron had expressed the opposite view.

Mr. Pearson supported the views expressed by Dr. McMartin. He was grateful that a system of monoculture had even been recommended on the coast. He himself would even go as far as to doubt the efficacy of a green manure crop and would prefer to see cane following cane. He thought our practice of leaving trash on the ground encouraged bacterial activity and encouraged root growth on the surface of the soil. He would like to see further work/done on these aspects. Our knowledge of bacterial activity was very limited and therefore work in this direction should be started. He asked Prof. Theron what he considered was the most important function of humus, was it a plant food or merely a sponge that could hold moisture and fertilizer?

Prof. Theron stated that in his opinion humus played many parts, but the essential function which could not be replaced by any other means such as fertilising or irrigating, was its ability to build up crumb structure in the soil.

Mr. Du Toit referred to Prof. Theron's theories in connection with nitrogen and phosphate requirements of plants which he said were not only of special interest to the Natal sugar-belt, but also to other sugar-growing countries.

The facts were that in countries such as South Africa, Mauritius, Australia, Louisiana, etc., where either a fallow period was allowed before planting or a green manure was incorporated or both, plant cane received less nitrogenous fertilizer than ratoons. Prof. Theron maintained that plant roots and particularly roots of grasses, stopped nitrification after about a year and that the organic status of soils were thus conserved but that the plants then needed more nitrogenous fertilizers. This then fitted in well with the above-mentioned experience of cane growing. In countries such as Hawaii and Trinidad, however, where there were no fallow periods and cane was planted immediately after cane, the amount of nitrogen applied to plant cane was as big or bigger than that applied to ratoons. Prof. Theron further maintained that although nitrification was stopped under a grass cover, ammonification proceeded uninterruptedly. That being the case,

however, and it being known that ratoon cane responded excellently to ammoniacal nitrogen, why should there be a greater need in ratoons than in plant for nitrogenous fertilizers? The explanation always accepted in the sugar industry was that there was an accumulation of available nitrogen during the fallow period and that this reduced the requirements of nitrogenous fertilizer in plant cane.

Prof. Theron also maintained that responses to superphosphate were outstanding when new land, rich in humus, was ploughed. He felt that this was largely due to micro-organisms locking up the phosphate during a period of rapid breakdown of organic matter. After a time, however, the phosphate response disappeared with the lowering of the organic matter status of the soil or in old grasslands. Prof. Theron referred to the experience of the sugarcane areas, where a big response was found to phosphatic applications in plant cane, but not in ratoons.

In Natal excellent responses in plant cane were obtained to phosphates in virgin soils and generally the responses in ratoons were disappointing. The reason, however, was that the plant cane was given more or less enough phosphate to last for a complete cycle of ratoons and that the phosphate would not be placed so well in ratoons, although there was no doubt some uptake through the trash blanket in ratoons. In countries such as Jamaica it was also found that responses which were very evident in plant cane disappeared in ratoons, but where the phosphate would be well placed, such as in the Louisiana bank system, the phosphate responses in ratoons were as big as in plant cane. Furthermore, the amount of trash incorporated in the land after ploughing out an old cane field was very large and yet the responses to phosphate fertilizers were not as spectacular as in virgin lands. It was, therefore, somewhat difficult to accept the theory that the original spectacular response in virgin soil was due to a lack of phosphate by micro-organisms only, if the latter did not take place with vast amounts of trash incorporated in the soil.

Mr. Barnes thought that the monoculture of sugar was no evil. The statement by Dr. de Castro was entirely incorrect. In the West Indies there were fields which have produced cane and no other crop since about 1775. The then owner of some of these fields found that certain of them could produce only three ratoons while others could produce seven. That condition persisted to this day, though the fertility of the soil has been improved, as shown by increased yields in recent years. Sugarcane no doubt acted as the ideal ley. It afforded much better protection than any other form of agriculture. He thought Prof. Theron's address would provide an adequate answer to the people who maintained that our monocultural practice was wrong. It was not

the sugarcane which brought about slavery in the West Indies, it was the fact that the local population were not prepared to work for anybody. More or less the same thing had happened in Natal, when labour had to be imported because the local population would not work in the fields. It applied to many other tropical crops.

Mr. Palairet said that our experience with sugarcane was in one respect at variance with that of annual crops, in that the destruction of roots does not appear to lead to soil exhaustion and erosion. In the old days before trash-blanketing, experience taught us to off-bar our cane, which is nothing more or less than a drastic root pruning. Apparently the old roots rot into humus sufficiently to maintain soil structure and cane grows new roots very quickly. We found that it was the friction of tillage implements which destroyed soil structure.

Prof. Theron replied that according to his original hypotheses nitrification does not take place under the perennial crop but ammonification is not in any way interfered with. He still had an open mind on this question, however, and later experiments have shown that other factors are also involved but he believed that the key to the problem of humus mineralisation and nitrification is to be sought in that general direction.

As regards the responses observed to phosphate applications with plant cane but not ratoons, the problem seems to be exactly the same as with grasses. The newly established grass, like the newly established sugarcane, does not respond to nitrogen but does markedly to phosphates, the reverse being true for the ratoon crop. Where, however, the grass is heavily fertilised and high yields result, a phosphate deficiency is induced, with the result that a marked nitrogen-phosphate interaction is obtained—similar to the observations quoted by Mr. Du Toit for heavily fertilised sugarcane. It is plainly a question of the heavier growth induced by the nitrogen applied, resulting in a demand for phosphate in excess of what the soil can supply.

The experience in some sugar-growing areas overseas, that a nitrogen response is obtained with plant cane, where planting takes immediately after the previous ratoon is ploughed up, is readily explicable, in view of the fact that inhibition of nitrification persists for some time, particularly in heavy soils, after the perennial crop is ploughed out; where the new crop thus follows immediately it is possible that the inhibitory factor is re-established in the soil before any material amount of nitrification can take place; hence the nitrogen response as with the ratoon.

As far as the trash cover is concerned, he did not think that any material amount of the trash became tied up in the soil as humus.