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SEVEN YEARS OF SOIL SURVEY ON A BIODYNAMIC FARM

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The farm about which we report is located near Chester, New York in Southern Orange County. It was purchased in 1944. At that time the soils and fields showed signs of neglect, the low-lying fields were wet and no drainage system existed. There were lots of weeds everywhere. The fences were a stimulant rather than a hindrance to the cattle, bossy needed only to lean gently against them and walk through. The farm is a typical dairy farm with about 30 to 34 acres under cultivation for field crops, 74 acres of hayfields (chiefly clover and mixed hay), and 50 acres of permanent pasture, some very wet. All of the hayfields have been through the crop rotation since 1944. In fact, it appeared that they began to improve only after they were once plowed up. The soil in the older hayfields had become sticky and packed. All the soils are brown, medium-heavy clay soils; some of the bottomland is quite heavy but not loamy. All of the fields contain lots of stones. About half of the farm is on slopes, some rather steep, but no erosion has been observed during the years. The rest of the fields lie in bottomland with a creek winding through it. There are many springs on the hillsides. The major problem from a physical point of view was the improvement of structure and drainage. Most of the bottomland and some of the hillsides were waterlogged. The farm offered a good opportunity to study the effects of poor and good drainage. About an even number of fields belongs to each group. The drainage program consisted of blasting ditches (1947 and 1948) and using a drag line (1951). Great improvements have been observed as the result of these measures, although the whole program is not as yet completed.

The crop rotation has been a very conservative one. For instance, corn for silage has been followed by winter wheat. Then grass-clover mixtures for hay have been sown into the wheat. When this was not possible because of excessive drought in late summer and fall, a green manuring crop of rye was sown and oats with a grass-clover mixture followed this. Fields were kept in hay for from two to four years according to conditions. Then the hayfield was plowed up and frequently sown to sudan grass or to soy beans. In earlier years corn was more often used on the plowed up land, especially on the well-drained soils. Recently soy beans have been planted the first year after plowing and corn the second year. This produces a smoother soil. The crop rotation in general, therefore, has consisted of two open years followed by four years in cover. This rotation fitted best into the dairy program, providing roughage, pasture, corn for silage, some corn for seed, and some wheat, rye, and oats for feeding.

Manure treated along biodynamic lines was used at the rate of 10 tons per acre for corn, and at the rate of 5 tons per acre as a top-dressing on older hayfields. Since 1952 the B.D. Compost Starter has been applied to the manure before taking it away to the field or manure composting pile. In a few instances the B.D.

field spray has been used. Before 1953 the B.D. preparations were used in the customary way for composting.

At first some fields were limed at the rate of 1 ton per acre and some phosphate was applied but only as much as is needed to sprinkle in the gutter and on the alley in the stable, which amounts to about 10 to 20 pounds per day or about 30 pounds per acre (and this reached only those fields which were manured). We saw no necessity of applying more lime and phosphate inasmuch as the acidity of the fields improved and plant leaves and tissue did not show any signs of phosphate deficiency. We will deal more fully with the problem of NPK under the individual headings later on. After the initial period of conversion the need for lime and phosphate became less and less. Since this is a factual report of observations and analyses no discussion of pros and cons will be presented here. The major aim of the management was to increase the organic matter first of all and then to see what else had to be done. This reporter's policy is entirely governed by facts and figures and is in no way dogmatic.

It was observed that under the conservative crop rotation and field management 10 tons of manure per acre once in a rotation period of four to six years, especially on well-drained fields, was sufficient to bring about signficant improvement *in the long run.* I emphasize in the long run, for on a year to year basis neither manure nor fertilizer always showed up at once. Sometimes no immediate fertilizer effects were seen. Sometimes the effect of manure showed up in the analysis only in the second year. However, every time the B. D. preparations were used, especially No. 500, we found a significant trend toward betterment. During the last two years, with the use of the B. D. Compost Starter, the trend upward has been considerably greater than in previous years. The improvement, however, or decline, whichever occurred, were much influenced by the state of the fields (wet or dry) and the weather of the year (wet, average, or dry) as well as the cultivation and organic matter level. The fluctuations and organic matter level reflected the moisture pattern, more clearly, indeed, than any other single factor.

The changes in acidity and organic matter content in previous years have been reported in this magazine in earlier issues. (1) This paper presents the whole survey over the seven year period from 1947 to 1954. Some, but not all soil tests were made prior to 1947. The analytical approach is described at the end of the paper.

The effects of the intended improvements began to show up gradually. It has been the writer's experience in managing farms under varying conditions for the last 25 years, that the building up of neglected and run down soils is a matter of many years. On soils with a low organic matter content (below 2 per cent) organic improvements are most spectacular at the beginning and slow down at higher levels. On farms with a 2 to 3 percent or better organic matter level, improvements move more slowly and become spectacular only if and when the B.D. Compost Starter has been applied. In general, it will take at least 5 years under favorable conditions and 7, even 10 years under unfavorable conditions to reach the goal. But all soils can be improved if the moisture conditions are favorable, periods of drought are the only real handicap.

The first improvement to be seen was that the quality of the crops improved, namely, the protein content of wheat, corn, silage and the vitamin content (A and C) as well as the mineral content of the grains. (2 and 3). These increases were observed as early as 1948. At about the same time, and increasingly, clover and alfalfa began to volunteer. Much later it became apparent that the hayfields with grass-clover mixtures lasted longer, for example 4 to 6 years instead of the previous 2 to 3 years. This fact, however, became more evident after we had the old hay fields plowed up and reseeded. Plowing speeds up the process as against trying to improve old, worn-out hayfields without plowing them under. Next an improvement in the feeding quality of roughage was observed and last of all increases of yield in bushels or tons. However, the first we noticed by way of increased yield was in the case of silage corn. This, with a shortened growth period, showed startling increases from 7 to 10 and now to a steady 17-20 tons of silage corn per acre. In recent years, therefore, we have filled our silo (80 ton silo) from a smaller acreage. In the beginning 10 acres of silage corn did not fill it, now we fill it easily with the production of 5 to 6 acres. The yield by weight is determined to a large extent by moisture conditions. It was observed that in dry years on improved fields the corn yielded as much as in wet years, provided it was cut at the right time. Wheat yields were close to an even 36 bushels per acre (the New York State average being 25 bushels per acre). Extended droughts had a depressing effect on dry fields. Most fields with poor drainage yielded lower. In fact, we had a crop failure on a field one year due to excessive moisture. Hay yields have slowly increased and begin to show up more in recent years, i.e. towards the end of the period. This is best seen in the fact that the expense for purchased feed has dropped one-third on the same head-to-be-fed level. There was a quantitative increase of hay yields from 1.5 tons per acre to over 2 tons per acre in average years. While in earlier years the farm had to buy additional hay, especially in dry years, this is no longer necessary (at the same livestock level). Last winter some good alfalfa hay was bought as additional feeding and as a substitute for grain supplement. The milk production dropped. It increased again after we stopped feeding the bought alfalfa hay and the cows got back to home-grown mixed and timothy hay (no alfalfa)! Twenty-three Holstein cows produced 205,216 pounds of milk in 1948. In 1953 twenty cows produced 212,799 pounds of milk. Improvement was visible in the physical condition of the herd as well as in the production figures, due mainly to improved hay quality and pastures. The improvement of hay and silage was also reflected in their protein content. In the year 1953 we had an exceptionally dry summer and fall. However, our corn was still green at a time and age when neighboring fields of corn had turned yellow.

This process of gradual improvement was followed by soil tests. During the first three years only sporadic tests were made. Beginning in 1947 regular tests were conducted on 20 different fields, taking the soil samples in early spring, when, according to our experience, the values are at their lowest. Since there is a seasonal fluctuation, with a low during winter, again in July and August, and a high in May and in wet and warm Octobers, we decided to take samples only in spring at one of the low times. In this way annual tests can be compared with one another. No sample taken in March should ever be compared with one taken in May. The differences due to varying availability are sometimes greater in samples from the same field at different seasons of the year, than those from field to field. Fluctuations on the same field were observed throughout the years. Improvement did not follow a steady line upward but there were ups and downs with a traceable gradual upgrade. It is, therefore, necessary to evaluate the "*trends*" upward or downward. Improvement cannot continue indefinitely. After a while a stable or balanced situation is reached. The "*trends*" then level out, but the impact of excessive moisture or drought is felt less on such improved fields. This stability is quite agreeable to the farm management as regards easier field cultivation and steady yields.

The improvement of organic matter: The following figures tell the story.

I. Percentage of Fields at Different Organic Matter Levels 1947-1954

% Organic Matter	1947	1948	1949	1950	1951	1952	1953	1954
1 to 2.9	24	22	26	18	26	4	0	1
3 to 3.9	47	44	32	36	57	48	36	12
4 to 4.9	29	28	27	41	17	39	52	60
5 and more	0	6	5	5	0	9	12	27

These are the actual figures. The trends as influenced by poor and good drainage and dry and wet years are quite spectacular and are shown in the next table, number II. The percent of fields is recorded here which showed an upward or downward trend or no significant change under the described conditions. (The symbol nfg in all the following tables means no field in this group.)

II. Trends in Organic Matter Levels with Different Drainage in Different Years.

Type of Drainage	Kind of Year	Upward Trend				Downward Trend				No Change			
		Organic Matter Level in Per Cent											
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	0	0	100	50	100	100	0	0	0	0	0	50
poor	average	0	43	100	nfg	100	43	0	0	0	14	0	0
poor	dry	0	29	81	100	100	57	13	0	14	14	6	0
good	wet	16	60	100	nfg	32	40	0	nfg	52	0	0	nfg
good	average	0	18	86	100	50	64	14	0	50	18	0	0
good	dry	0	50	60	50	100	37	20	25	0	13	20	25

These "trends" tell an interesting story. First of all, fields with a low organic matter level do not improve in wet years except when the drainage is good. This fact makes it difficult to get a start if one wants to improve fields in the low organic group. This also explains why such poor fields respond so well to fertilizers and manures. Manures and composts as well as green manuring are paramount in order to effect improvements. However, all efforts will fail unless there is good drainage. It is an absolute necessity to improve the drainage of wet fields. Without it one will not succeed. The writer has learned this lesson the hard way. He is now of the opinion (which may seem extreme to some) that no expense for drainage is too much. He would advise the farmer, and especially the one who cares about organic improvement, to pay as much as he can possibly afford for drainage. Drainage measures should have priority over manure, compost and fertilizer. The hundred per cent downward trend on wet fields in any one year at the low organic matter level cannot be stemmed even by large doses of manure or compost unless somehow one succeeds in raising the organic matter level. This, however, can be done only on well-drained fields and there only slowly at first. We have seen fields in this group, under wet conditions, especially clay soils and heavy clay soils, which swallowed manure year after year for many years before improvements were visible. There is also the difficulty that poorly drained soils cake easily when they get dry, i.e. in dry years. Therefore a dry year will not help much unless the field is well cultivated and aerated. Wet pastures and hayfields will behave particularly badly. If one looks upon the soil as a system of interlocking factors (in addition to the already mentioned there are structure, microlife, method of cultivation) then this principle can be easily understood. Lighter, sandier soils behave better and are easier to improve. They respond more quickly if properly handled and not overcropped. Muck soils, due to their high moisture content are the worst to work with. It is the skill of the cultivator which will decide between success and failure at the low organic matter level. Simply to apply organic matter and do nothing else frequently ends in complete deception. At the higher organic matter level, best at 4 to 5%, poor drainage in wet and average years can be compensated for by the increased application of organic matter and proper cultivation. However, here a certain deteriorating effect can be seen on dry soils and in dry years. This is due to the fact that such soils may "burn" out. Our experience indicates that fields at the 5% organic matter level with poor drainage have all shown improvement in dry years. Those with good drainage, at the 4 to 5% organic matter level, behaved in the same way. In average years, in the latter case, they at least maintained themselves.

With increasing organic matter soils become more stable as far as the downward trend is concerned. This is especially the case with wet soils. Dry, or may we say over-dry soils, after prolonged drought periods suffer a certain loss of organic matter which needs to be replenished by additional gifts of manure, compost, green manuring, cover crops or mulching. Mulching would prevent such losses. The same principle applies to Southern soils with exposure to much greater heat and drought in general. The ideal conditions are given when the rate of precipitation and evaporation is balanced, which, of course, is the ideal climate. When this climate does not exist the farmer has to balance out the differences with organic matter, skill in cultivation, and cover crops to create a favorable microclimate.

The situation may not look at all rosy in the beginning for low organic matter soils and we can appreciate such claims as are voiced by agricultural experts when they speak of the law of diminishing returns. This law applies to soils of low organic matter content. The great Liebig himself found that his discoveries applied best to such soils and that his theory did not fit in at high organic matter levels. It is possible, however, to improve soils, as we have demonstrated on the reporter's farm; that is, to move them out of the danger zone within a few years and—this is important—at a cost which a dirt farmer can afford. For this was the way we made a living on this farm, as dirt farmers with no capital backing. In support of this it may be stated that the earnings of the farm enabled its management to pay off initial debts and mortgage to the tune of about $10,000 during ten years. In other words, it can be done.

A number of general conclusions can be drawn from all that has been presented so far. These can be stated in the form of a rule in the case of organic matter. Wet soils in wet years decline. Dry soils in dry years are in danger. Wet soils in wet and dryer years improve with increasing organic matter levels. Dry soils improve more evidently in wet and average years; more clearly on lower and medium organic matter levels before the "saturation" point has been reached.

We come now to the second chapter of our subject, the changes and fluctuations of other factors than that of organic matter. An analysis of all the data over the seven year period from the spring of 1947 through the spring of 1954 revealed great fluctuations which could not be explained in terms of added manure, compost, mineral fertilizers or crop rotation alone. A careful study taught us to make a differential breakdown with regard to various organic matter levels, poor and good drainage wet, dry, or average years. Then a clearer pattern evolved which is outlined in the following text and tables.

There is a marked difference between lower (1-3%) and higher 3-5%) organic matter levels. Each group of the following behaves differently with regard to these factors: pH, available potash, available phosphate, nitrate, lime, and bacteria count. Each is, therefore, reported separately. All in all over 1800 single factors had to be evaluated and placed within their proper group.

The results with regard to soil reaction (pH). pH is the standard expression for soil reaction. 7.0 is neutral and ideal, above 7.0 is alkaline, 6.0 to 6.9 is slightly acid, 5.0 to 5.9 acid. Most crops in the area of the farm grow best at a pH of 6.0 to 6.9, especially clover and alfalfa. Corn and potatoes can take a little more acidity. Again let us first look at the actual changes in pH over the seven year period. The beginning with more than

III. Percentage of Fields in Different pH Groups

pH	Reaction	1947	1948	1949	1950	1951	1952	1953	1954
5.0-5.9	acid	59	6	25	22	17	17	16	10
6.0-6.9	slightly acid	35	82	75	61	43	66	44	80
7.0	neutral	6	12	0	17	40	17	40	10

half of the soils in the acid range was not encouraging. Drainage has an important influence on the soil reaction. The general trend over the years is away from excessive acidity toward a better soil reaction. It was not necessary to obtain a neutral state or an alkaline reaction on this farm. We could not find that liming had any striking beneficial effect upon the soil reaction but found that drainage and high organic matter levels were more important. The differential in dry and wet years, good and poor drainage bears out this fact. In addition, it appeared that good cultivation and aeration comprised another important factor in regard to soil reaction.

IV. Trends and Fluctuation of pH with Good or Poor Drainage in Different Seasons in Percent of Fields

Type of Drainage	Kind of Year	Upward Trend				Downward Trend				No Change			
		% Organic Matter Level											
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	0	50	60	0	67	50	0	0	33	0	40	100
poor	average	100	53	20	nfg	0	35	60	nfg	0	12	20	nfg
poor	dry	33	58	25	57	66	42	47	53	0	0	31	0
good	wet	40	57	nfg	nfg	60	43	nfg	nfg	0	0	nfg	nfg
good	average	50	75	50	50	50	12	32	0	0	13	18	50
good	dry	nfg	55	31	25	nfg	45	61	75	nfg	0	8	0

The highlights to be gleaned from this table are: Poor drainage, and low organic matter in wet years show a prevailing downward trend. At higher organic matter levels this trend is reversed or at least fields maintain their level. Good drainage effects a decrease of acidity. Poorly drained fields with a low organic matter improve faster in pH than at higher organic matter levels. Dry years and poor drainage at a low organic matter level reveal a prevalent downward trend. Evidently the caking of wet soils as they dry has a bearing. Good drainage and average years show up best at moderate organic matter levels. Fields with good drainage begin to suffer from drought in dry years in respect of pH maintenance. Both the extremes of wet-wet and dry-dry are not favorable to the pH fluctuation.

One might ask why the acidity of dry fields increases in dry years. Under the extreme described conditions an unfavorable development of microlife occurs, the structure and aeration of the soil are changed, and organic matter breaks down more quickly—all of these could account for this phenomenon. Then too, some of the breakdown organisms which are favored by higher temperatures develop acid. We also found that there was a reduction of actinomycetes and soil fungi under such conditions. The process is reversible, however, on the high organic matter soils as soon as the moisture supply is sufficient, and no permanent harm is done. On the contrary, at low organic matter levels too much moisture has an accumulative destructive effect.

Trends and fluctuations in the case of nitrates (*NO3*). Nitrates may be looked upon as the end products of a biological process in soils (nitrification process due to the activity of nitrogen fixing bacteria and to nitrate formers) no matter from which source the nitrogen derives, air, organic matter, manure, fertilizer, or legumes. The nitrate findings of the various fields present a peculiar pattern with values as low as 8, 12, 16 and 20 pounds per acre in 1947, and sudden high peaks in 1949 and 1954. Manuring has a bearing on these peaks as well as legume crops. The very same field seems to be satisfied with low values one year and high values another year. It is sometimes difficult to give any explanation. The method already applied by differentiating between dry and wet years, poor and good drainage, and organic matter levels offers a certain key. However, we do not pretend that we have all the answers as yet. One thing is sure, wherever the biodynamically treated manure and during the last year the B. D. Compost Starter have been applied more "peaks" showed up. Excessive nitrogen on fields exposed to erosion—and by this we mean not only surface erosion but also a washing downward which we would like to call "chemical" erosion—is to be avoided. Our "high" nitrate findings climbed to levels which are quite unusual on farms of this type, namely, 48, 64, 100 and more pounds per acre. Nitrogen never was a problem on this farm, except in the very beginning. It should never be, because organic matter, according to the scientific literature, contains 5% nitrogen. A soil with 2% organic matter or 40,000 pounds per acre thus has an organic nitrogen reserve of 2000 pounds. A soil with 4% organic matter would have a reserve of 4000 pounds. It is the biochemical or better microbial activity in the soil which determines how much of the organic nitrogen is transformed into nitrate in addition to the nitrate sources from manure and fertilizer. Processes of increased microbiological activity in the root area of certain crops also increase nitrate. Therefore, the amount of nitrate does not indicate the absolute amount of nitrogen present but is only a relative figure, indicating to what extent the nitrification process took place and drew from any nitrogen source. On soils of a low organic matter level the problem is entirely different. Other observations lead to the statement that 1.5% organic is the critical level below which the drawing on natural resources of nitrogen ceases and then the nitrogen deficiency pattern, so often referred to in modern agriculture, actually develops. Continuous cropping aggravates the problem.

V. Percentage of Fields at Different Nitrate Levels

Pounds of NO3 Per Acre	1947	1948	1949	1950	1951	1952	1953	1954
Below 24	100	44	21	32	25	33	57	4
24-47	0	43	26	51	33	50	30	29
48 and over	0	13	53	17	42	17	13	67

The trends upward and downward in relation to wet or dry years, good or poor drainage, and different organic matter levels are also interesting.

VI. Trends in the Fluctuation of Nitrates at Different Organic Matter Levels

Type of Drainage	Kind of Year	Upward Trend				Downward Trend (Organic Matter Level)				No Change			
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	80	33	25	50	20	67	50	50	0	0	25	0
poor	average	100	50	20	nfg	0	43	60	nfg	0	7	20	nfg
poor	dry	67	29	73	54	33	71	19	28	0	0	8	18
good	wet	40	72	nfg	nfg	20	0	nfg	nfg	40	28	nfg	nfg
good	average	100	38	67	34	0	50	33	33	0	12	0	33
good	dry	nfg	36	57	50	nfg	55	43	50	nfg	9	0	0

At the low organic matter level soils behave best under average moisture conditions. Wet soils with poor drainage have the greatest difficulty in regard to nitrate. The pattern at higher organic matter levels is irregular and does not permit the establishment of definite rules. Evidently factors other than that of states of moisture influence the formation of nitrate. Such factors are the application of manure, the plowing under of green manure crops, grass sods, and legumes. The application of manure has much increased the nitrate in all cases of favorable moisture conditions; in cases where the moisture conditions were unfavorable the nitrate increase from manure showed up only in the second year. Striking increases were observed where the B. D. Compost Starter had been applied. In dry and wet years, fields with poor drainage reacted unfavorably. Some fields under favorable conditions, when cultivated that is well aerated, also showed startling increases even though they had not received any manure. The fluctuations on any one field from year to year can be quite great. To say, therefore, once a good field always a good field, would be a great error as far as nitrate is concerned. It requires constant attention. Plowing up and burning out can lead to quick losses. The same applies to irrigation, nothing can ruin a soil faster than over-irrigation.

Available potash follows a peculiar pattern which is not easily understood. There are the influences of wetness, dryness, of manure or fertilizer, and of the organic matter levels. The findings will be presented first and followed by their discussion. The fluctuations were not great, mainly ranging between 100 and 200 pounds per acre, with a few below and some above a median level at the end of the seven year period.

VII. Percentage of Fields at Different Available Potash Levels

Pounds of Potash Per Acre	1948	1949	1950	1951	1952	1953	1954
Below 100	88	50	18	13	0	16	4
100-150	6	41	69	43	40	38	83
160 and up	6	9	13	44	60	46	13

VIII. Trends in Fluctuations of Available Potash at Different Levels of Organic Matter, Drainage, in Different Years

Type of Drainage	Kind of Year	Upward Trend				Downward Trend				No Change			
		Organic Matter Levels											
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	25	nfg	0	0	50	nfg	75	0	25	nfg	25	100
poor	average	50	57	60	nfg	50	43	20	nfg	0	0	20	nfg
poor	dry	34	58	38	25	32	28	50	72	34	14	12	0
good	wet	0	34	nfg	nfg	50	32	nfg	nfg	50	34	nfg	nfg
good	average	100	50	50	100	0	37	17	0	0	13	33	0
good	dry	nfg	28	36	0	nfg	54	28	50	nfg	18	36	50

We see here a general trend away from the lower bracket over the years. When high organic matter levels are reached the availability drops again, not because of a deficiency, but because of the unique property of potash to enter as yet unknown compounds with organic matter. On such soil with organically bound potash we now see potash deficiency symptoms in plants and in leaf analyses. The biochemistry in the rhizosphere of the living plant and microlife are able to get at this potash but our analytical extraction method does not. We have not yet been able to overcome this difficulty. In making quantitative analyses for total potash one observes low potash values at low potash and organic levels, but high potash vaules at high organic levels which don't show up in the extraction method.

In considering the trends one finds that wet soils suffer in wet years except at the 5% organic matter level. The latter maintain themselves. In average years it is about a fifty-fifty proposition, better at the 4-5% organic matter level. In dry years, the changes though recognizable are not significant.

Dry soils on the lower level suffer in wet years. In average years on dry soils at the lowest and the highest levels we got a hundred per cent improvement. The rest is more or less a matter of maintenance. In dry years dry soils suffer and on higher organic levels lock up the potash. Well-controlled moisture is essential for available potash. This explains why in the dry winter of 1953-54 we had a depression on the highest organic matter level while average soils increased the percentage in the medium bracket (100-150 pounds). Except for the potash content of the applied manure and of plowed under sods or green manure, no potash fertilizer has been applied on the farm. There has never been a potash deficiency in any of the crops. Since the soils are all rather stony it was felt that with the proper management of soil life enough potash would be released from the native stones and rock of the plagioclase and orthoclase types to provide potash needs. (These are two types of feldspar, both containing potash compounds.) On dead soils as well as on a pure loam or clay soil the matter may be different. Some fields showed increases of available potash after manuring, others not. There was no clear pattern of reaction so that we can not say all potash was due to the manure. Manure under unfavorable conditions as outlined above did not increase the potash availability.

Trends and fluctuation of available phosphate. The variations in available phosphate are quite significant at the different organic matter levels and as influenced by dry and moist conditions. The availibility of phosphate is a function of the total amount of the soil reserve, if any, of the fertilizer or manure applied, of the microlife in soil which renders phospates available, and of the moisture conditions, to list a few of the more important factors.

IX. Percentage of Fields at Different Available Phosphate Levels

Pounds of Phosphate per Acre	1947	1948	1949	1950	1951	1952	1953	1954
below 75	26	50	54	14	31	31	24	8
75-150	48	44	37	50	50	43	42	46
150 and up	26	6	9	36	19	26	34	46

This again presents the actual figures. The trends are quite characteristic.

X. Trends in Fluctuations of Available Phosphates at Different Levels of Organic Matter, Drainage, in Different Years

Type of Drainage	Kind of Year	Upward Trend				Downward Trend Organic Matter Levels				No Change			
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	50	50	50	50	50	50	50	50	0	0	0	0
poor	average	50	29	40	nfg	50	64	40	nfg	0	7	20	nfg
poor	dry	100	86	50	72	0	14	25	28	0	0	25	0
good	wet	20	50	nfg	nfg	80	50	nfg	nfg	0	0	nfg	nfg
good	average	0	38	33	50	0	38	50	0	100	24	17	50
good	dry	nfg	65	72	0	nfg	18	21	0	nfg	17	7	100

On soils with poor drainage in wet years and at any organic matter the same percentage of soils improve or decline. An increase of available phosphate could only be brought about by adding phosphates to the soil in some form. But in dry years considerable amounts of phosphate were released especially at the lowest, medium and very high organic matter levels. We purposely say "released" for not all increases of available phosphate could be accounted for by fertilization. In fact, with one exception, there was no instance in which fertilizing with phospate had any infuence in producing an upward trend. Years after a phosphate application a decline of available phosphate even showed up due to the fact that it had become locked up in the soil. It is our opinion that the mobilization of phosphates is an important task of the microlife and is influenced by soil reaction.

The steady increase of available phosphate during the years is therefore a result of the organic and microbial improvement on the farm. For a further study of this problem we refer you to the fourth listing in the appended bibliography. (4)

A sharp increase of available phosphate appeared during the last year where the B. D. Compost Starter had been used, that is, Starter treated manure, especially in the garden. It would now be of interest to analyze for total phosphates in addition to tests for the available in order to determine how much the potential reserve of a given soil is. Dairy farmers in the area have been advised by Cornell and County Agents that 30 pounds of phosphate per acre are enough under Southern New York State conditions, particularly on soils which have been overdosed with phosphates in the past. We agree. As a general rule, on our farm, we would say that phospates can take some moisture and that well-drained soils in dry years at higher organic levels maintain themselves, while well-drained soils in wet years suffer, particularly at the low organic level.

Trends and fluctuations of calcium carbonate (lime). All the soils on this farm were low in lime content although no marked calcium deficiency was evident either in the feed or in the plant growth in general. The tests were made for the exchange calcium content not the absolute content. After the drainage program was completed only a few soils and the house garden recently showed a significant increase of exchange calcium to a high level without any lime being added. In wet years and on wet soils we observed that all lime was locked up in the soil. Even when one ton of lime per acre was added the test revealed after a few months only traces of exchange calcium. This reminds the writer of something that happened many years ago in Holland. There acid, wet pastures were limed every year with the result that the following year they were as acid and deficient in lime as before. Then one experimental station began to dig down into the deeper layers of the soil. All of the lime was found down in the deeper layers, inaccessible to the plant roots. In fact, the depth of the lime strata could be used to calculate how many decades or centuries ago a "polder" had been reclaimed and put under cultivation. This is a typical case for the interaction of "locking up" and chemical, that is *vertical* erosion, since these soils are all level. Then there are also the hillsides in Southern England and in the Swiss Jurassian mountains, where the topsoils are quite deficient in lime although only a few inches beneath there lies limestone rock.

The question of lime boils down the problem of whether a soil is able to mobilize lime by its microlife in the root areas of the plants. Since our soils did improve in acidity anyhow and become more neutral we did not see any point in introducing a program of heavy liming. Only as much lime was used as that so generously provided by the soil conservation agency as a "must". By this we mean that if you don't lime you are not considered to be a good farmer. We would rather spend all available money on drainage rather than on lime for our place. But such is life. In other words we are not lime addicts. But we are magnesium addicts. Many Eastern soils are deficient in magnesium. If lime must be used it should be dolomite limestone. However, unless all the other factors in a soil are under control one can pump a mountain of limestone into a soil with no visible result. On the other hand, if everything goes well very little is needed. The reader may understand from this that we are not in any way dogmatic about the question. What we dread when liming is that it may be locked up, the crusted, hardened soil with its reduced aeration, and the tying down of trace minerals. However, this is supposed to be a factual report and no arguments need be stirred up.

XI. Percentage of Fields at Different Calcium Levels (Lime)

Pounds of Lime Per Acre	1947	1950	1951	1952	1953	1954
below 400	61*	54	76	68	68	64
400-1000	39	46	16	16	--	--
1000-2000	0	0	8	16	32**	36**

*with lots of liming
**with no liming

During 1948 and 1949, with five exceptions, all lime was locked up in the soil. These were wet years. The trends are more interesting.

XII. Trends and Fluctuations of Exchange Calcium at Different Levels of Organic Matter, Drainage, in Different Years

Type of Drainage	Kind of Year	Upward Trend				Downward Trend Organic Matter Levels				No Change			
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	17	0	0	0	17	100	50	100	66	0	50	0
poor	average	0	35	60	nfg	100	50	40	nfg	0	15	0	nfg
poor	dry	100	58	64	67	0	42	25	29	0	0	11	4
good	wet	0	0	nfg	nfg	75	50	nfg	nfg	25	50	nfg	nfg
good	average	0	13	33	100	100	50	50	0	0	37	17	0
good	dry	nfg	65	50	50	nfg	18	21	25	nfg	17	29	25

The great downward trends which reveal the ineffectiveness of liming appear on poorly drained fields in wet years, even to a certain extent in average years. While the lime content increases on fields with poor drainage in dry years. Good drainage at low organic matter levels did not effect much increase in average years either. Higher organic matter levels helped. The following conclusion may be taken with a grain of salt: if you wish to bring about an increase of exchange calcium beware of wet conditions.

Trends and fluctuations of bacteria counts. Bacteria counts have not yet become a part of routine soil analyses. They are strictly laboratory methods in the hands of experienced personnel. Since we were specifically interested in all soil organisms and their relationship to the processes in soil which lead to humus, and since the Biochemical Research Laboratory had carried on a great deal of research in the bacteriological background of composting, there was no difficulty about making checks on the bacteria count and the bacteria species in soils. The method used was of our own choice. The figures obtained should not be compared with the literature on the subject as different counting methods give quite different figures. According to our standard, 100 million bacteria per gram of sample is low, 250 million medium high. 500 million represents the count, with our method, of the best virgin soils. This standard has been established on the basis of hundreds of samples from many sources. This standard applies to aerobic bacteria. Anaerobic organisms prevail in waterlogged soils and mucks. 10 million anaerobic would be normal for our soils. A higher count of anaerobes is not desirable.

The count in itself is a symptom, but should be further developed to a determination of typical soil species, ammonifying, nitrifying, cellulose digesting bacteria. These details are not reported here. A comprehensive study of this problem will appear at some later date. It suffices to state here that the counts reported are of typical soil bacteria not of b. coli and other organisms present in fresh manure.

XIII. Percentage of Fields at Different Levels of Aerobic Bacteriological Activity

Count in Millions Per Gram	1949	1950	1951	1952	1953	1954
below 100	55	77	29	33	25	21
100-250	31	5	31	33	50	49
250 and over	14	18	40	34	25	30

XIV. Trends and Fluctuation of the Aerobic Bacteria Count as Related to Different Organic Matter Levels and Drainage Conditions
(In percentage of fields belonging to each group)

Type of Drainage	Kind of Year	Upward Trend				Downward Trend				No Change			
		Organic Matter Levels											
		1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6	1-3	3-4	4-5	5-6
poor	wet	0	x	60	0	100	x	0	0	(	x	40	100
poor	average	100	58	30	nfg	0	42	60	nfg	0	0	10	nfg
poor	dry	100	43	25	57	0	43	44	43	0	14	31	0
good	wet	0	0	nfg	x	50	50	nfg	x	50	50	nfg	x
good	average	50	63	50	50	50	25	32	0	0	12	18	50
good	dry	nfg	54	31	25	nfg	36	61	75	nfg	10	8	0

The changes in aerobic bacteria counts are only part of a great number of tests made over a period of years, which are reported here. It seems that the trends in the bacteria count of aerobic soil organisms are more marked at lower organic matter levels. Here greater fluctuations are observed than at higher levels where a kind of saturation point is reached. One observes a certain balance after awhile of optimum conditions. When these have been reached no major changes take place. So much for the numerical values of the count. The qualitative differences of the various species are quite another matter. Under the most favorable conditions azotobacter and actinomycetes, for instance, will form a much higher percentage of the total than at lower levels.

At the 1 to 3% organic matter level, in wet years poorly drained fields show a 100% decrease. Wet, watterlogged soils are inimical to aerobic bacteria. In average and dry years the same fields present a 100% increase. The increase slows down with rising organic levels except in the case of the 5% level in dry years, probably due to a greater capacity for water retention. Poorly drained fields on higher organic matter levels give irregular counts in dry years or show a decline. Structure and pH may have a bearing on their behavior.

Manuring with treated manure as well as the plowing under of legumes increases the bacteria count appreciably, sometimes more in the following year than in the first. Poor hay fields always have a low count. Well-drained soils decline in wet years, they behave best in average years. High organic matter levels suffer in dry years. These fields get really dry in dry years. In wet fields at high levels there is residual absorbed moisture, at low levels actual moisture.

The application of the B.D Compost Starter in 1953-54 doubled the count in almost all cases. Many questions with regard to the bacteriological process in soils are still open and cannot be answered as yet. From the theoretical viewpoint we think in the same terms as Lyle Wynd in his article "Feed Your Soil" (5 & 6) : that is, that organic matter in any form is the food for the microlife in soil, and this in turn will prepare a good soil for you. But you have to give soil life a chance by creating optimal conditions. Just to throw fertilizer, composts, or fresh manure on the land will not solve the problem. You ought to know what your organic matter contains and in what state of decomposition it is. You also ought to know whether your soil is a good "receptacle" or not.

In summarizing all the data and information received, we arrive at the following conclusions in regard to the test farm:

	Number of Improvements	Number of Downward Trends
Soils in wet years — poor drainage	5	11
Soils in average years — poor drainage	11	8
Soils in dry years — poor drainage	12	5
Soils in wet years — good drainage	7	5
Soils in average years — good drainage	14	5
Soils in dry years — good drainage	12	5
Totals	61	39

(The No Change bracket has been omitted from this table.)

The proportional relationship of improvements to poor drainage and good drainage is expressed in 28:33.

The proportional relationship of downward trends to poor drainage and good drainage is 24:15.

Distributed over different organic matter levels the matter thus appears as follows:

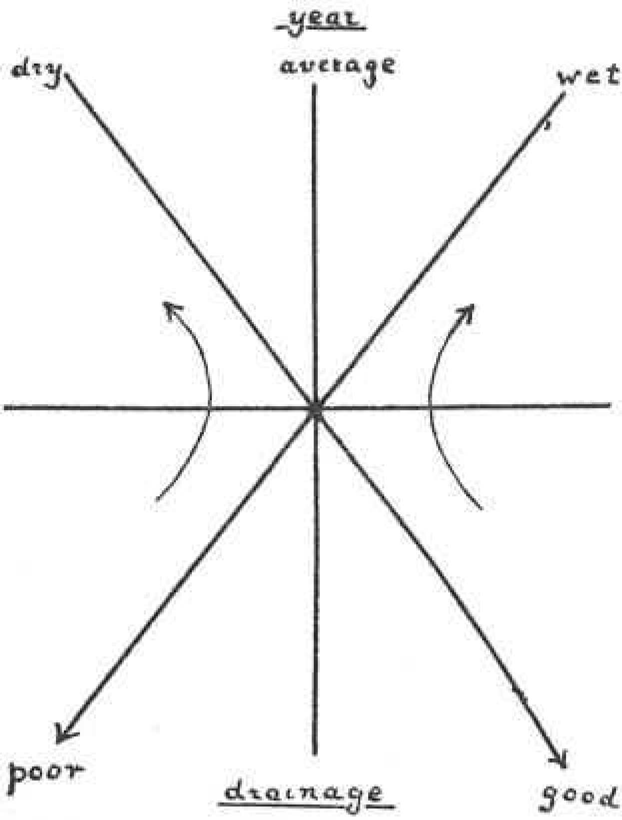
XVI. Number of Improvements and Downward Trends

Type of Drainage	Kind of Year	Organic Matter Levels							
		1-3%		3-4%		4-5%		5-6%	
		Up	Down	Up	Down	Up	Down	Up	Down
poor	wet	2	3	1	4	2	2	0	1
poor	average	3	0	4	5	4	3	nfg	nfg
poor	dry	5	1	3	2	4	2	nfg	nfg
good	wet	1	3	3	1	0	1	3	0
good	average	2	1	4	2	5	3	3	0
good	dry	0	0	4	3	6	1	2	1
Totals		13	8	19	17	21	12	8	2

With rising organic matter, improvements rise (the lower figures in the 5 to 6% group are caused by the fact that the majority of these fields, especially in the poor drainage group, remained in the No Change bracket which is omitted from this table).

Some pertinent general conclusions. The proportion between upward and downward trends increases with rising organic matter levels in favor of the upward trend. Wet fields behave better in dry years at low level, dry fields behave better in moist years at higher levels. We may express this rule in a general way in a sketch.

This sketch presents a simple generalized rule for the practical farmer who has no opportunity of controlling every detail by analyses. To read it: Connect opposite corners and you will get a downward trend. Connect points on the same side (right or left) and you will get an upward trend. The trend shifts toward more favorable conditions with rising organic matter. With decreasing organic matter the trend shifts toward the unfavorable and deficiency symptoms become more apparent. These are also more pronounced at opposite corners of the chart. Finally, we may say that all improvements progress slowly: all decline is swift. In other words, it takes a long time to build up a soil, but it can be destroyed very quickly. However, in the upbuilding stage soils improve quickly until they reach an optimum when they begin to maintain themselves; the breakdown moves faster at low organic matter levels. Improvements can be made at the dirt farmers level. The term "balanced soils" acquires a new meaning. To get balanced soils is the aim of the farmer who loves his land.



Analytical methods used. Soil extraction methods of Truog and Morgan were used with colorimetric determination of pH, potash, nitrate, and phosphates, and turbidity for calcium. The organic matter was determined by oxidation with Potassium Dichromate-Sulfuric Acid solution and titration with Ferrous Ammonium Sulfate solution. The bacteria count was determined by plating out on beef-agar-peptone, incubated at 29° Centigrade for 48 hours. The same person carried out all the tests in order to secure uniformity. Air-dried samples were used in all cases, except for bacteria counts which were made from the original samples as received. All samples were processed at once after they were taken. The same person collected all samples on about the same location in the field, again for the sake of uniformity. In sampling, the top inch layer of soil was discarded and the samples were taken from the 2-6 inch depth. All samples were taken each year during the last week of March or the first week of April after the first, or winter moisture, had gone out of the ground and the soils were reasonably dry, i.e. ready for field work, but before cultivation and sowing. At least 5 samples were taken from each field and used for one average sample. Sampling errors could thus be reduced to a minimum.

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4. "Availability of Nitrogen, Phosphate and Potash in Soils" by E. E. Pfeiffer, BIO-DYNAMICS, Vol. X, No. 3, 1952.
5. "Feed the Soil", by F. L. Wynd. THE SCIENCE MONTHLY, Vol. LXXIV, No. 4, 1952.
6. "Microorganisms and their Effects on Crops and Soils" by T. M. McCalla and T. H. Goodding. Circular 90, April 1951. Nebraska Agricultural Experiment Station.

BY ALL MEANS USE THE BIO-DYNAMIC SPRAY

Our Bio-Dynamic Sprays 500 and 501 have each to be stirred for one hour to prepare them for immediate use. Since the beginning there have been efforts to find a mechanical way of doing this. Of the many efforts, a few have been relatively successful. Nothing quite takes the place of the hand stirring, but rather than neglect the use of these vital sprays, it is possible to use labor-saving devices. The latest to be tested at Dr. Pfeiffer's laboratory, is a small Monitor Washing Machine, made of stainless steel which holds one portion of spray. It is so efficient in combining air with the liquid that the job can be done in a half hour instead of an hour. If you need a second portion, you can stir that in the machine while you spray out the first.

One of our Association members deals in these machines and can order for you from the nearest warehouse to you in order to save on transportation cost. On orders sent to him he will give half of his profits to Bio-Dynamics. Those interested may write directly to

Mr. Fred. O. Schwender, Schwender's Inc., 201 Columbia St., Utica, New York.

NEW TYPEWRITER NEEDED

During the war when typewriters were scarce, the Association managed to get a second-hand one which we have been using to date. It was an old model then, it is decrepit now. We need a new one badly but as we have recently purchased a new addressing machine, we can't afford a typewriter too just now. In case any of you who read this should have a good standard machine of any make which you do not use and could spare to us, we should be grateful indeed.

E.S.

TWO BIO-DYNAMIC CONFERENCES

Happy associations of many past summers will be renewed at Threefold Farm the week-end of July 30, 31 and August 1. If you have never attended a Bio-Dynamic Conference this is by far your best chance to learn basic principles and see Bio-Dynamic demonstrations. Also there will be special lectures and reports, discussion with opportunity to ask questions, visits to Dr. Pfeiffer's Laboratory and to several gardens, and the annual meeting of the Bio-Dynamic Farming and Gardening Association. This latter has particular significance—a brief glimpse into the past, the story of Bio-Dynamic development—for we celebrate the thirtieth anniversary of its organized beginning in the summer of 1924 in Central Europe.

Sessions open with a special lecture and demonstration at four o'clock on Friday afternoon, and close after the Sunday evening gathering. Detailed programs available later, but it is important that with so short a Conference, everyone should attend throughout. Tuition fee for the whole Conference—$4.00.

To make your reservations for living accommodations, send a $3.00 deposit to Mrs. Elizabeth Kroth, Threefold Farm, Spring Valley, New York.

The Bio-Dynamic Conference to be held in September at Golden Acres Farm, Newtown, Pa., is to be for FARMERS ONLY, a strictly professional gathering. There will be a flexible program of farm sight-seeing, questions and answers, discussion and some lectures. Bring comfortable clothing, walking shoes and a good notebook. This is a meeting for serious work and will, it is hoped, be the beginning of yearly farm study conferences for those who want to apply Bio-Dynamics. Living accommodations with Bio-Dynamic food, at rates similar to those at Threefold Farm, will be available nearby. To be sure of these, your reservations must be in by September 10 at headquarters of Bio-Dynamic Farming & Gardening Association, R.D. 1, Chester, New York. The first session will be on Friday evening Sept. 17, the last on Sunday evening Sept. 19. To follow its continuity and get the most from this Conference, you should not miss any sessions, as it will not lend itself to selective attendance.

DR. PFEIFFER'S BASIC BOOK AVAILABLE—"Bio-Dynamic Farming and Gardening" has been out of print for some time. Now we find that copies of the fine edition from Faber and Faber of London can be had for those who need the book now, $2.75 plus postage. Please write Bio-Dynamic Farming & Gardening Assoc., Inc., R.R.1, Chester, New York.

FEATHERY EGGS AND SPONGE CAKES

HELEN PHILBRICK

They say "Those who can, do; those who can't write." For quite a few years we have maintained a small flock of hens with the smug feeling that we were following all the rules and that the flock was small enough so that all was well and nothing could go wrong with it. For a family of four persons, twelve hens will supply enough eggs except during the seasons in the year when eggs are scarce everwhere. Each hen is supposed to have 2 square feet of housing and four square feet of range or yard space. When we moved our little flock into their new house we were careful to place the orange-crate nests on the dark side of the house because Mrs. Hen prefers to snuggle into a shadowy place to lay her eggs. Acting on the knowledge that most of the hen manure falls under the roosts during the night, we built a dropping pit under removable roosts, covered with wire. Into the pit we scatter hay or straw or corn cobs, a layer of each to cover the last layer of droppings. We also sprinkle the pit with B. D. Starter. When I recall what a job it used to be in the old days to clean the roosts with a hoe and carry the hot, heavy manure in bushel baskets, it is a joy—almost—to dig the light fluffy material out of the dropping pit and layer it on the compost heap.

Out in the henyard there is plenty of sunshine for "the girls", plenty of opportunity to luxuriate in dust baths, and when the young plum trees grow a little bigger, there should be shade from the sun when it gets too hot.

How true it is that "the best laid plans of mice and men" often go off on an unforseen tangent. In our case, it was a few hens which someone wanted to sell. We bought them to be helpful and added them to our own flock increasing the number to twice as many as the house should contain.

In spite of plenty of food and water, feather pecking began but because we were busy with other affairs, we paid little attention until the breakfast eggs began to taste as though they were stuffed with feathers. Another factor which may have contributed to the general subnormal health of the flock may have been the laying mash which we had been buying already ground and "micro-mixed" with several kinds of antibiotics.Ever since we learned that the efffect of these antibiotics is passed into the human system from eating the eggs, we have tried to find ways to avoid feeding this laying mash.

One day we read in FERTILITY FARMING by Newman Turner:

> "A number of poultry farmers troubled with feather pecking and cannibalism among their birds are finding that the actual feeding of compost to hens in folds, or any kind of confinement, puts a stop to the habit. It is well known that these troubles are due to a deficiency of some natural element in the diet, and it seems that compost provides it."

His recommendation is to build the compost pile in one yard while the hens are using another. When the compost is ready for use, the hens are turned into the first yard and a second compost heap is built in the other yard. He further states that the earthworms provide the kind of protein feed the hens crave.

It was not practical to build a compost heap exclusively for the hens but we were more than willing to share ours with them. Every day we put a wheelbarrow load of well-ripened compost in the henyard. (The hens eat the compost, manufacture the eggs, and the hen manure goes back into a different compost heap.) Whole scratch grain and the alfalfa leaves which fall into the bottom of the milk goats' feeder, supplemented with table scraps have further changed the hens' diet. Every other day we hang a cabbage in the henhouse, just above the hens' reach so that they are kept busy reaching for it and batting it back and forth, until it is devoured. They also get a dishful of sour milk every day. The milk, at least is raised here on the Homestead, and perhaps next year the cabbages also will be.

The first change we looked for was improvement in the flavor of the eggs. Now after three or four weeks of the new diet the eggs are entirely different in taste. No more "feathers in the yolks"!

Another change which we had not anticipated is that the hens now eat much less of the "complete" laying mash than formerly, although they lay just as many, if not more, eggs. When the pile of egg boxes gets too high we bake a series of sponge cakes and freeze them in the deep freeze to use next summer when fresh eggs are more rare.

The final reform which we hope will soon take place in our henhouse is to reduce the size of the flock, back to the twelve birds who should be living in that house.

There are many techniques that are not in any textbook. First of all the rule to pay close attention to the hens themselves, to learn what they have to teach us about their own habits and preferences and conditions. Yesterday while I was watching the hens from the kitchen window, I learned another little bit about the way all the creatures on the homestead, both wild and tame, fit together in their work. An English Sparrow was sitting on a fence post (The hens chase him off the ground when he alights in their yard.) Out the door of the goat barn flew a grain moth. The sparrow flew over and caught it. He flew back to the post pulled the moth apart, ate the part he wanted and dropped the wings into the henyard where the rooster gobbled them down. If we had eyes to see, I am sure we would find many instances of the wild creatures influencing our tame ones, with benefit to everyone, even as the English Sparrow helps control the grain moths.

ANGLES AND ASPECTS OF ORGANICS

PETER ESCHER

"Organics," as it is known in the English-speaking world today is essentially a farming and gardening practice that was re-invented in India. India, significantly enough, is a country with what we call a low standard of living, a place where the wages are very low and labor is abundant.

Furthermore, only the idea of composting was transplanted from there into our gardening technique. Strangely enough the technique of gardening and farming used by the tiller of the soil in India, the old rules of thumb and all that grew out of his almost instinctive relationship to soil and plants, have been overlooked somewhere along the line. Composting appears as the starting point of "Organics," although it is true that certain practices were later added as a corollary.

Isn't a dairy or beef farmer who spreads his manure also an organic farmer? Logically it would seem that he would have to be included under the definition even though he may add some lime and some phosphates—under a different name of course. He may even have become aware of trace elements, and add some of these to his soil. What, then, is the fertilizer balance of most dairy farmers today? The average dairy farmer buys his dairy feed, produces his own silage and hay, and maybe some small grain. He buys feed in addition to what he grows, in order to enable him to milk more cows. He spreads all his manure. Yet he has to buy lime in order to keep the soils from becoming too acid, he has to purchase phosphates to overcome an apparent deficiency here, and sometimes has to purchase nitrogenous fertilizer "to make his corn grow," or for his pastures and hay fields.

By looking at some of these farms, one finds that they often have difficulties in growing clover, let alone alfalfa. To get a good stand of alfalfa is becoming increasingly harder and stands of clover do not remain as long as they used to. The pastures—some of them in inaccessible places — have in general become poorer. This results in a feed deficiency, primarily as regards protein. So what is happening is that high cost feed has to be purchased in order to overcome a fertilizer deficiency.

In this connection it is interesting to note that on some well-known Bio-dynamic farms it has been found that the cows eat and want little or no dairy concentrates while they are on a pasture provided with sufficient moisture.

The dairy farmers—organic farmers in fact but not in name—suffer from a deficiency of fertilizer. Some of it may be due to improper farming methods, improper tillage. The dairy farmer's basic reasoning is to obtain, or nowadays at least to maintain, as high a milk check as possible and to allot a certain percentage of it to the various expenses. Instead of looking at manure as a revenue, it is looked upon as a necessary evil and handled accordingly. The idea of trying to make the most of his manure is not considered.

The pure organicist looks at the problem from a different angle. The soil is depleted, organic matter has to be added. This can be done by purchasing organic matter from outside sources when these are available, by keeping more cattle and thus buying more feed, or by plowing under crops. If a crop is plowed under, what happens? The seed has to be purchased, the field has to be tilled, the crop, instead of being harvested, has to be plowed in. Result: loss of a crop and a high cost of fertilizer. This cost has to be absorbed either by capitalizing it—which generally ends by selling the farm—or by growing a truck crop, that is, a crop which fetches a higher price. This is profitable in truck growing regions, where sufficient labor for planting and harvesting is available.

From the economic point of view, what does the organicist do? It has been found that composting—that is, in the way in which he has been doing it—is not feasible. Hence sheet composting is being advocated. The dairy farmer, of course, has been doing just that since time immemorial, with results that are well known. Hence more stuff has to be added. Layers 5 inches thick of cow manure, chicken manure, straw, have been observed on hay fields. Often it is even seen that different materials are spread on the same field, with the results that growth in different parts of the fields varies widely. The sheet compost lies on top of the poor plants striving to find a way through that layer of material. Do they like it? The weeds that eventually grow on top seem to thrive. The stuff that has been spread, or sheet composted as it is called, is, of course, not available to the roots of the plants where it should be. The spread materials on top dry out. Underneath, above the soil, you can find a nice growth of fungi until the spread materials have finally decomposed, but by that time the original pasture of hay plants has given up the struggle.

On one organic farm, manure was purchased from the stockyard and hauled to the farm in such quantities that it kept several trucks busy day in day out. The manure was then piled, and later was spread on the fields at a rate of 125 tons per acre, which is equal to a layer of about 3/4 inches of manure on the entire surface. The crops planted on those fields grew so fast that most of them lodged . Of course the manure in these fields will eventually rot, but why lose all that time and have to wait so long until organic matter has decomposed in the soil?

One field on the same farm had compost treated with B.D. Starter. The compost was applied at a rate of 25 tons per acre. That field was in much better shape than the others, and the plants growing there were stocky. And not too far away there is a small Bio-Dynamic garden, attended with loving care, its soil in excellent shape.

In Northern Europe we find another way of using organic matter. In many places the city garbage is dumped somewhere out in the country. That garbage, by the way, is not exactly separated, it contains some tin cans, bottles, and, in winter, a lot of coal ashes. All that stuff is left to rot. Later on the local farmers pick it up and put it on their fields at a rate of about 25 ton per acre. Obviously, it costs money to haul and spread manure and then to let it finish rotting in the soil. One cannot help asking whether those farmers would not be better off if, instead, they could get and use a small quantity of really good compost.

Tremendous applications of manure are by no means new in these parts, i.e. the U.S.A. Writes Peter Henderson in 1886: "Rotted stable manure, to produce full crops, should be spread on the ground not less than three inches thick (our market gardeners use from fifty to seventy-five tons of well-rotted stable manure per acre, when no concentrated fertilizer is used), and should be thoroughly mixed with the soil by plowing."*

When they used concentrated fertilizer such as guano, the recommended quantity of stable manure, to be first plowed in, was 25 to 30 tons per acre. Such practices have had to be abandoned long ago,what with high and ever rising labor costs, increasing scarcity of labor, the advent of chemical fertilizers and the passing of our friend the horse.

Today the vegetable or truck grower has the problem of the ever decreasing organic matter content of his soil and a slowly but insidiously growing fertilizer bill to face.

The organic method has not even attempted to face this problem: How can a truck grower with 10 acres or with 5,000 acres maintain the fertility of his soil? Generally he has no animal manure available, and but little vegetable refuse—which he considers as a nuisance.

Some people sell organic matter under various euphemistic names, most of it being dehydrated chicken or cow manure marketed with but little regard to its effect on the soil or plants. One University is experimenting with compost from garbage. They even made an experiment with the Starter, but couldn't find any discernible benefit. Their bulletin indicates that this institution of higher learning did not find it necessary to follow instructions on how to use the Starter, although the report, on the same page, concerning tests of an "inoculum" mentions specifically that it was "prepared in accordance with the directions of the manufacturer."*

The organic movement itself has, it appears, for the most part simply continued the practices of fertilizing which were used prior to the use of commercial fertilizers. The truck growers had found out long before that they could not fertilize their truck crops economically by using manures. The organic movement apparently was blissfully unaware of that fact. It embel-

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*GARDENING FOR PROFIT, by Peter Henderson. O Judd Co., New York, 1887. Page 40.

*See BIO-DYNAMICS, Winter-Spring 1952, pages 18-21, for report on the use of the Starter by large-scale commercial growers.

lished the old methods by advocating mulching, which is alright in a garden but not feasible on any larger scale. It took a strong and laudable stand against spraying poisonous sprays, but without finding any practical substitute.

After a time, it advocated sheet composting: in other words its method of composting was unsuccessful and the process of decomposition was transferred from the compost pile directly to the field. Now the job of breaking down compost materials has been relegated to the soil. Organic enthusiasts who accept this approach evidently take only rare walks through the woods to see how long it takes nature to break down organic matter. The soil bacteria are, by this sheet composting, absorbed in the chore of breaking down the compost materials. It can take them quite a long time too, and it is done in a haphazard way. The materials that are not broken down are of no use to the soil. If they were broken down, they would have the same, or a higher capacity of water absorption as the parts which are broken down, and they would be available as plant food.

"Organics," apparently having found deficiencies in its methods of composting, is now advocating the use of fertilizers which are neither of animal origin nor of vegetable origin and yet, since they are not synthetically produced, are therefore called "natural."

PLANNING FOR THE HOME VEGETABLE GARDEN*

EVELYN SPEIDEN

Self-sufficiency in a biological sense, is a necessity which arises out of the problems of the present economic system, and which will contribute to the solution of these problems. It is a necessity for the farmer who wishes to preserve the fertility of the land eventually to be inherited by his children. Not only must the farmer be worthy of what has been entrusted to him, but he must build his means of production on a solid foundation. When he has accomplished this first task, he can begin to think of cash crops which will provide money to buy things he cannot produce himself.

The idea of self-sufficiency extends beyond the farmer; it includes the small landholder who needs to wring a living out of a small acreage. Also it offers an opportunity to the man with a modest income from another source who owns a small piece of land and wishes to keep in touch with the productive forces of nature. Even for the city dweller, tired of stone walls and paved streets, it provides the joy of having a little piece of the

*Rewritten from GROW A GARDEN, E. Pfeiffer & E. Riese. Anthroposophic Press, New York. 1942.

earth's surface on which to cultivate flowers and vegetables in leisure hours, and the discovery that there is nothing so enjoyable and healthful as tasty, home-grown vegetables, ripened on his own fertile soil, moistened by the rains, swept by the winds, warmed by the sun, cultivated and raised by his own efforts, cooked and eaten the very day they are picked.

Those who thus come into contact with nature's living forces, soon find that no food chemistry, no adding to or subtracting from food, can improve on nature's original product. Whatever their motives for acquiring small garden plots, be it duty, pleasure, business, recreation or to find a balance for mechanical or intellectual pursuits, all these people wish to succeed in their venture. This necessitates a coordination of careful planning and skillful execution.

Ethical and aesthetic, as distinguished from economic values, need also to be appreciated. This we can understand as we observe the phenomena of growth in the warmth and light of the sun, as we become conscious of the changing seasons with their varying weather pictures. We experience it in the pleasure of watching the gradual development of plant life, in the quickened movement of the blood in our veins as we till the soil, weed out rank growths and harvest the good and useful. These are values not measurable in dollars and cents. Their ultimate importance is in the building of character. One who loves the soil develops a finer awareness of the synthesizing processes, the upbuilding forces of the world. He cares less and less for the more destructive, disintegrating processes. Gradually he becomes the bearer of a new mentality, capable of perceiving the permanent truths of life itself. However, the physical basis for the successful, small holding has to be built first. This is the primary task.

From a practical viewpoint, the small garden should furnish food, if not all one needs, at least an abundance. Also we must always remember that the beautiful flowers in the garden are food in another sense—food for eyes and nose. Even the most commercial garden can create a balance of beauty while fulfilling biological health requirements, making a total biological unit.

The smallholder's garden, if planted and tended in accordance with the laws of nature, life and maintenance, is in reality, a living being—a biologically sound totality—as regards self-sufficiency, healthy growth, and human food requirements. Monoculture is out of the question in such a unit. Neither the soil nor our stomachs would stand it. The balanced diet necessary for health presupposes a balanced production.

Proper planning first requires a consideration of our needs. The human being eats six, seven or eight times his own weight each year. The annual food consumption per head in the United States, according to statistics, is as follows:

Carbohydrates:		
	Bread and other flour products	230 pounds
	Potatoes	180 "
	Sugar	100 "
Proteins, etc.:		
	Milk	200 "
	Meat (including fish and fowl)	166 "
	Eggs	36 "
	Nuts, etc.	20 "
Living energy:		
	Vegetables	300 "
	Fruit (including citrus fruits and tomatoes)	72 "
	Oils and fats (including butter)	44 "
		1348 pounds

This, however, allows a wide margin for the individual. Other figures show an increasing demand for vegetables and fruit, and that is the very thing the smallholder's garden can contribute: greater health values. What is biologically right is economically sound and healthful too.

The planting system to be described later, and worked out in practice through many years, enables the smallest and poorest holder, as well as the great landowner, to produce with the least effort that which the body requires.

Moreover, whoever likes to dig deeper into the truths of nature will be surprised and pleased to discover how justly the good earth works to build up a closed biological unit—the little garden—in order to support that other closed biological unit—man himself.

We must consider three different aspects when planning the home garden; our needs, the size of the garden, and the quality of the soil, this latter being primary and basic. Include also the environmental conditions, especially climate. The intensity of cultivation is dependent upon it. In a rain-poor climate, a dry, sandy soil forms little humus, is quickly warmed by the sun, but cools off quickly too. On cool, clear nights it is liable to frost; on hot days the sand becomes overheated through reflection. A permanent ground cover and shading of the soil is necessary here. Cultures must be selected and mixed, with this in mind. Mulching gives its greatest benefits with such soils. They can be planted very early in Spring, as soon as it begins to get warm, although we must remember they are very susceptible to night frosts. With a great deal of humus added, they are suitable for early seed beds and portable cold frames.

A wet, tough, clay soil stands at the opposite pole. It is cold, warms slowly, dries slowly, in wet weather can be worked with difficulty or not at all. Lack of proper soil drainage is its worst enemy. Everything depends on selecting the right moment for cultivation. The gardener must wait until it is dry enough and then work quickly. The ability to handle a heavy soil correctly is achieved only through experience. It should be left rough after plowing or spading in fall, so that thorough freezing is assured over winter. During or after wet periods, beds should be heaped up and rounded so that more air penetrates and water can run off and evaporate. Deep-rooting legumes have a remedial effect in the cultivation of heavy soils, and should be used often.

The ideal soil is the humus type with a loose and crumbly structure and a rich content of ripe, earthy, organic matter. It responds quickly to cultivation. Soil bacteria and earthworms care for its constant renewal. So great is its excellence that every measure for the attainment and maintenance of humus structure is justified, even if it involves extra labor and expense. Once attained, this friable, healthy condition saves labor and fully repays our original investment of time and energy. Whether soil is sandy or clayey, however, we can by proper treatment of it, become independent of the soil type. A humus-bound sand having some clay content, given the right care and continued fertilizing with compost and manure, can be just as fertile as a humus-filled clay soil. The extremes are brought into balance by the humus.

The lay of the land is also important. Low lying areas should be laid out with raised beds to regulate the air and water content. Wind protection must be provided in the layout. (Windbreaks.) Steep slopes should be terraced not only to gain surface area, but to facilitate cultivation and avoid gullying and sheet erosion. Lay out garden beds at right angles to the slope and in contour, otherwise good soil will be washed down to the foot and the upper areas will become poorer and poorer. The intense radiation on a southern slope must be compensated for by soil shading, with closer planting or mulching, or both. On a northern slope it may be necessary to plant a thinner stand. In rolling or hilly land the planting should follow the line of the ridges.

The size of a home garden is usually definitely limited. This fact combined with the quality of the soil, determines the approximate yield. However, the experienced gardener, with soil-conserving crop rotations, maintenance of humus content, correct soil cultivation, and the selection of suitable varieties, can, perhaps, harvest double as much from the same soil as the novice. Thus, the yield still depends on the person and his labor. Nevertheless certain figures based on experience enable us to foresee how nearly a garden may fulfill our needs.

To meet the food requirements of one person in the temperate zone, an area of about one and one-quarter acres (6000 sq. yds.) is needed in medium heavy soil with humus content. But that is not sufficient for complete self-support. This requires maintenance of the means of production to keep the land in a permanently vital state with fertilizer produced on the place itself. For self-sufficiency a few livestock are included to maintain the soil, and for their feed a small, plowed field and some pasture and hayland are needed in addition to the garden. Space is allowed too, for production of some cash crops such as milk, fruit, honey, vegetables, potatoes, pigs, eggs, etc., to meet costs of clothing, repairs on the house, tools, school, doctor, taxes and occasional recreation.

Let us, therefore, consider these three possibilities for supplying family needs: A. Self-support as regards vegetables with only the home garden; B. Self-sufficiency with respect to food on a middle-sized homestead with some outside help; C. the smallest sized farm which meets the needs of a modest, but independent existence.

A. SELF-SUPPORT AS REGARDS VEGETABLES. In the temperate zone with medium heavy soil, a home garden of about 1000 square feet with good care can yield approximately 675 to 700 pounds of various vegetables. An example of a mixed, soil-conserving planting that has often been used successfully, is as follows:

Average Yield of a Home Garden of 30 by 30 feet (with 14 beds of 4 by 15 feet each.)

Beans - green or lima	No. of Plants	Pounds
Pole	27	176
Bush	50	22 - 26
Beets	3 rows	26 (about 50 beets)
Cabages - early Savoy	14	26
late heads	29	88
kohl-rabi	50	11
red cabbage	12	44 - 50
(Broccoli, Brussels Sprouts, Cauliflower or Chinese Cabbage may be substituted)		
Carrots	6 rows	20
Celeriac or celery	18	13
Chard	4 rows	13 - 23
Corn	9	9 (about 20 ears)
Cucumbers	2	11
Herbs	32	
Leeks	32	9 - 13
Lettuce	46	31
Onions	85	31 - 35
Parsley	10	
Peas	4 rows	22
Peas, sugar podded	18	11 - 13
Radishes, early & late	58	6
Shallots or garlic	15	8 - 10
Squash - summer	1	11 - 18
Squash - winter	1	23 - 35
Tomatoes	15	66
Turnips	16	8
		685 - 736 lbs.

Study of such a table leads to the significant conclusion that there is a relationship between man and the biological laws of nature. Only mixed cultures and rotation of crops maintain soil fertility. The human being needs variety too, for the best nutrition. A monoculture for instance, of potatoes, red cabbage, beans or onions is a biological absurdity. Likewise a diet of any one of these alone would cause trouble to the human being. Both he and the soil require a variety of vegetables, frequent change and occasionally a bit of spicy, green herb.

Usually the vegetable supply for 3-4 persons can be grown in a home garden such as this, even though it may seem difficult for the beginner to produce so much on so small a piece of land. Nevertheless, increasing efficiency and the intensive work possible in a garden of this size, both contribute towards the goal. Hundreds of gardeners have obtained such yields.

B. SELF-SUFFICIENCY WITH RESPECT TO FOOD. The vegetable needs of a family of 2 adults and 3 children are between 660 and 1450 pounds. The space needed to grow this is between 1000 and 3000 square feet, depending on individual needs, type of soil and climate. On a small homestead of from 10,000 to 55,000 square feet, the basis of support, including the chief elements of nutrition, may be attained. As an example, a homestead of 13,500 square feet was actually observed in all its stages of development.

The owner, an industrial worker, purchased the land with his first savings, then built the house with the help of a small loan. He divided the land into three sections: 4500 square feet for vegetable garden; 4500 for house, lawn and flower garden, the remaining 4500 being seeded down to pasture.

In his vegetable garden he followed all the priciples of the bio-dynamic method; compost and manure treatment, crop rotation, mixed cultures, etc. Also he kept some poultry. In spare time, outside working hours, he attended to such matters as fencing, laying paths and building a road.

After three years the vegetables in his garden were excellent in quality and more than enough in quantity for his own household. With the cash obtained from the surplus, he was able to cover additional costs of bread, meat and milk as well as a third of his taxes.

Many other factory workers living near him have successfully followed in his footsteps. A carefully devised crop rotation enables such homesteaders to do all the work in their land in their spare time and with a minimum of effort.

C. INDEPENDENCE ON FIVE TO SEVEN ACRES (subsistence minimum). The small farmer's holding of a size which just maintains a family is an ideal of healthy self-sufficiency. Its size is conditioned by climate, soil type, amount of moisture and water supply. Such a holding furnishes a standard in an entire locality which has to reckon with the same conditions. On a small farm with a good ratio between tilled fields, pasture and hayland, the manure production can be brought into balance with the crop requirements. With a crop rotation of at least 4 to 6 years, diversified planting supplies food (bread, potatoes) for the household, fodder and straw (litter) for the cattle, as well as milk and meat. Doubtless there will be chickens too (eggs and meat), a small vegetable and herb garden and often a flower garden as well. Fruit trees and bees complete the picture.

It has been demonstrated over a period of more than twenty-five years, that such biologically sound farm units maintain the fertility of the soil without any loss of nutritive substances. A small farm with 40 to 60% tilled land and a corresponding area of pasture and hayland to support a proportionate number of cattle, can maintain itself and in addition produce cash crops on one to two fifths of the cultivated area. This is done by a long-term crop rotation, with not more than two grain years and at least one legume year in a five-year period. Such a holding can provide money for needs other than food, such as taxes, medicine, clothing, education.

An area sufficient to maintain a cow, a calf and a steer, gives us the smallest unit. Add the area devoted to food for human beings—at least one and a quarter acres per person, a certain "fertility reserve," and the area assigned to cash crops. Thus a small holding of five to seven and a half acres represents the smallest healthy unit on a soil of average quality, with medium rainfall (30 to 35 inches). The acreage is divided thus: one-fifth for vegetables, three-fifths for pasture and hayland, one-fifth for grain and fodder.

A detailed division of the garden area will grow out of particular needs. Any one-sided cultures are unhealthy for the soil and must be compensated for in the next year to maintain a well-regulated crop rotation. Fruit trees, berries, grapes and flowers can play both useful and ornamental roles in protective and boundary plantings, even in the larger plan. A low berry hedge may be a property line barrier or a border along a path or the street. Trees usually shade a garden too much, but planted to shade a path, the liquid manure barrel, the compost yard or even a summer house, they are in their proper place. It is strongly recommended that the space for every individual garden or group of gardens be enclosed. This is based on biological fundamentals such as shade, ripeness of the soil, protection of the soil's carbonic acid content, and to break the force of wind. Bushes or grapevines may make a perennial hedge; sunflowers, corn or pole beans an annual one. Flowers and medicinal or kitchen herbs are suitable for bordering beds and paths. Thus it is possible to create an enclosed growing space with comparatively simple means.