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ACCORDING TO HIS LIGHTS

By Kennett Harris

ILLUSTRATED BY W. H. D. KOERNER

"SO THIS is Pactola!" Rose drew rein to survey the scene of desolation, and her willing horse stopped before what had been Bolsovar's barroom and disdainfully nosed the sprays of wild raspberry that banked the bleached and rotting remains of a plank sidewalk. Stephen halted his steed, likewise, and availed himself of the young woman's abstraction to survey her. She was worth looking at. Well worth the while, and as long a while as decency might permit. Decidedly so! The scene itself, ruinous as it was, deserved more than a casual glance or two. A deserted mining camp.

Not an altogether melancholy prospect; for where the sun shines and water runs and the two combine to bring forth herbage and flowers and leafy trees, no place can be utterly mournful, and Pactola had all these, and no depressing history to evoke pensive sighs from the beholders of its blessed decay. It was a smiling prospect, in fact; triumphantly smiling. Man had come to this Eden of the hills and had done his ugly worst with ax and saw and pick and shovel to mar and blemish it. Nature had suffered the invasion of her solitude, borne with patience mutilation and disfigurement, and yielded her golden tribute easily. Then the invaders had departed, leaving her to nurse her wounds and restore her wonted comeliness with moss and vine and the soft-hued pigments of wind and weather.

Not much more than a straggling broken line of a single street along the course of a mountain stream; sagging roofs and walls of pine logs from which the bark was stripped in patches; rudely chinked and daubed log cabins, with here and there a sign whose faded lettering set forth some pretentious legend of business enterprise. The glass had disappeared from window frames, doorways gaped doorless or crazily ajar, and floors within were covered with litter of wind-blown leaves and weeds. Between the houses and the creek ran long trenches and uneven, grass-grown ridges, the work of the placer moles, and at one point in the burrowed hillside opposite, a cluster of dilapidated frame shacks surrounded two taller wooden structures from which extended a trestle leading to a pyramid of broken ore, and above which were some fallen sections of a flume.

"So this is Pactola!"

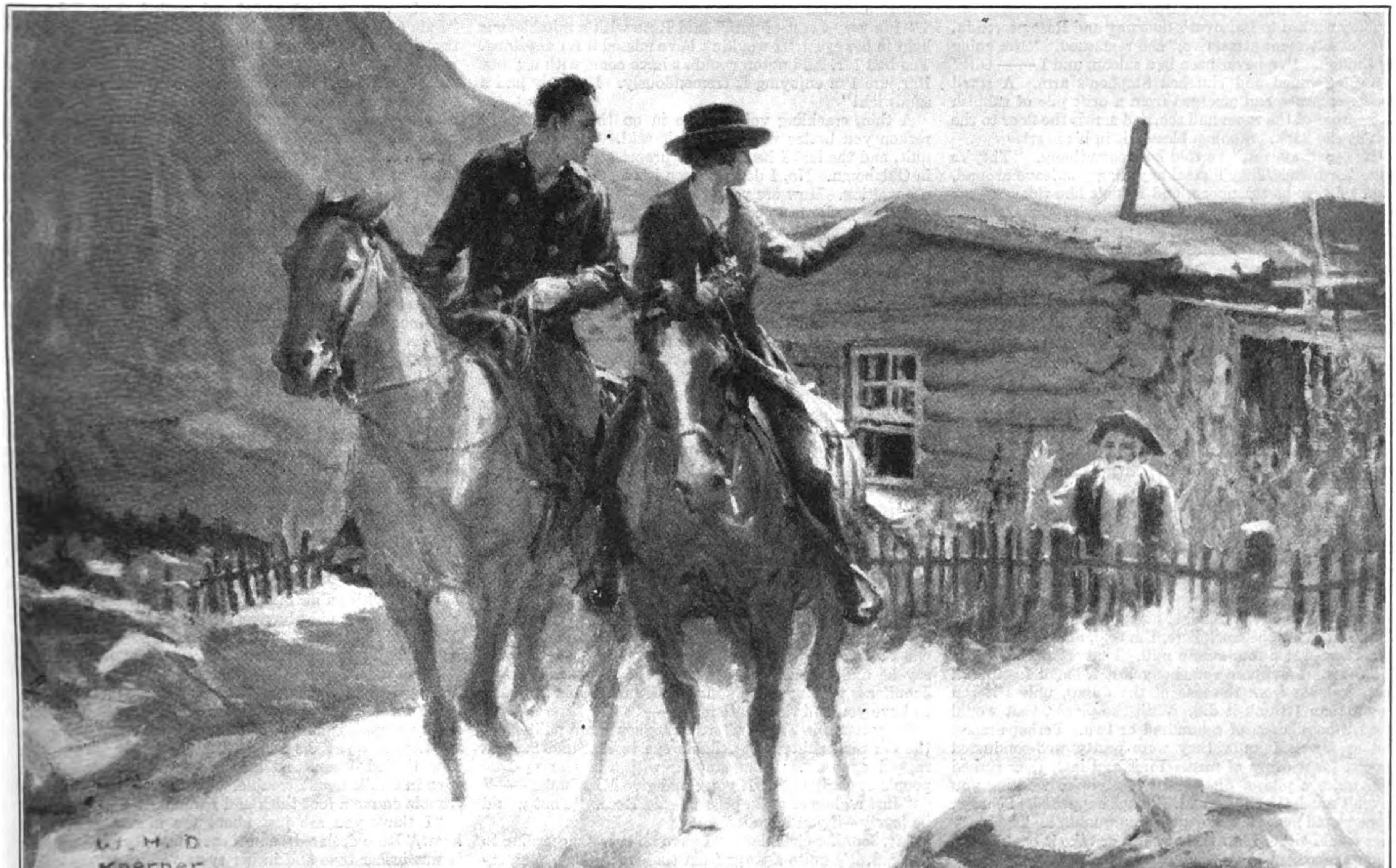
"This is Pactola," Stephen echoed. "There's Pactolus," he continued, waving to the creek, "and there Jamshid gloried and drank deep," he continued, indicating Mr. Bolsovar's once popular resort.

"It's weird!" said the girl. "To think of all that must have happened here, and now—the lion and the lizard. Are there any lions, do you think?"

"The mountain variety, I suppose," answered Stephen. "They won't be prowling at this time of day, though. Would you like to get down and stroll around the town?"

She dismounted lightly and he swung from his saddle and led his horse with hers to the part of Bolsovar's hitching rack still standing and tied them there, after testing the strength of the post. Then he waited while she flicked the dust from the skirts of her modish riding coat with an incongruous quirt of braided horsehair and then, tossing her gloves to him, reclaimed some straggling brown locks of hair with slender white fingers.

"No telling whom we may meet," she laughed.



Rose Waved Her Hand to Him, Blew Him a Kiss, and They Cantered Off

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PHILADELPHIA, OCTOBER 1, 1921

Money to Burn

MUNICIPAL and government ownership forms one of those spacious and comprehensive subjects which delight the heart of a publisher of college-debating outlines. But while the theoretical arguments extend in each direction out toward infinity, the ordinary citizen will find in his own supine indifference toward governmental finance the surest forecast of the probable outcome of such policies. Somehow government has become so complicated that people cease to realize that it is their own money which is being spent. Most citizens, even those who pay taxes, watch the struggle for lower expenditures and for tax and budget reform like spectators at a play.

How municipalities or other governments can operate industries which are now privately owned and managed with any degree of economy or efficiency unless citizens become far more vigilant than at present it is impossible to see. It is said that small shareholders in large corporations are indifferent and careless, and this accusation is probably true as long as all goes well. But the bitterness of even the smallest stockholder when dividends cease to arrive as usual is proverbial. Helpless and apathetic as are the small stockholders, they form protective committees in a remarkably short space of time when things go wrong; and when a corporation falls upon really evil days the display of self-interest among the various security holders and the conflict and ill feelings engendered by their efforts to preserve their property often exhaust every resource of the most brilliant legal minds.

But when we come to government the average man's behavior is utterly different. He glances at newspaper headlines which tell of revolving funds in the Treasury, of the War Finance Corporation, of half a billion which the Government owes the railroads or the railroads owe the Government—he does not know which—of a legislative investigation into the finances of the largest city in the country, of charges against the former treasurer of the second largest state, and so on indefinitely. He is slightly and mildly amused or irritated, that is all.

But just why is the citizen so unconcerned with tax raids upon his pocketbook? The answer lies no doubt in the comparative indirectness with which government expenses fall upon him. Only five million people pay income taxes and only a few thousand pay very large ones, and if there is unfairness or if injurious effects are produced by these taxes most people are more concerned in changing the form of taxation than in reducing the amount. But the nub of popular indifference to government waste or mismanagement lies in the fact that there are so many people, so many industries, so many different forms of wealth and income, that we all vaguely suppose the Government will get the money somehow, somewhere, sometime. What if the Shipping Board does need a billion or two? There are always clever experts who can think up new taxes.

But this is not an editorial on taxation; it is concerned solely with the likelihood of industries being operated economically and wisely by government. Suppose the Government should take over all the street car, light, power, railroad and telephone companies. John Smith, who owns fifteen shares in one of these companies now, doesn't contribute much to their success except his money, but he does get terribly mad when they stop paying dividends. But what will John Smith care when the Secretary of the Treasury tells a Senate Committee in executive session that he needs five hundred millions more for the telephone or electric industry? What is five hundred millions in a great rich country like this? For taxes can always be devised; or if there happens to be especially strong objection, the city or Government can always issue bonds. Taxable or tax exempt, in either case government and municipal bonds are regarded as the safest on earth. There are always buyers.

Or if the bond market happens to be a little glutted the Treasury can always put out a billion or so of short-term certificates of indebtedness, or give the revolving fund another revolution. The Government can always put out paper. It can enter into vast financial operations without anyone really caring much or being much the wiser or knowing what it all means.

But will John Smith know whether the industry for which the Secretary of the Treasury asks five hundred millions is mismanaged or not? What can he do if it is? What substitute is there like the passing of dividends under private ownership and management to sting him into action? Who will give a hang, anyway?

What under such circumstances is to prevent a gradual nibbling away at the cheese of national savings and capital until all is gone? What is to prevent a steady, progressive tuberculosis of national wealth and resources? More than one great nation has been ruined in the past by government waste and taxes. We have made a fine start.

The Blackwell Plan

IN THE summer of 1919 an inquiry set on foot by the Rotary Club, of Blackwell, Oklahoma, revealed the fact that of thirty-nine boys who were just out of grammar school eleven had found jobs and had decided not to go on with their schooling. Instead of wasting time in lamentations over the probability that more than a quarter of that year's output of the grammar school would go out into the world unequipped to compete with better-trained boys, the Rotarians of the town attacked the matter hammer and tongs and had the satisfaction of seeing every one of the thirty-nine enter high school.

Such were the modest beginnings of a movement that is already achieving national significance. In 1920 the Blackwell plan was tried out in many towns; and this year something like nine hundred Rotary Clubs, scattered all over this country and Canada, are making an intensive effort to stop the boy leakage between grammar and high schools.

The Rotarians of Memphis, Tennessee, after seven months of hard work, announce that out of two hundred fourteen boys who finished grammar school last June two hundred five have agreed to continue their studies this fall. A similar club in Newburgh, New York, has been concentrating on the thirty-two graduates of the local high school, with the noteworthy result that no fewer than twenty-five of them are about to enter college. Records like these are proof positive of the high possibilities of the back-to-school movement.

In Dallas, Texas, the Rotary Club maintains a loaning fund to assist poor boys who desire to continue their studies. Money is lent on the personal note of the borrower at four per cent interest, a life-insurance policy being the only security required by the club. This plan has worked out so well that it is spreading to other cities. In some places club members assist youngsters of slender means by finding them work that can be done out of school hours, in their own offices or elsewhere.

The Rotarians have already sufficient practical experience with their back-to-school movement to enable them to standardize their local campaigns and to conduct them along definite, systematic lines. Well-tried methods are employed and the chances of failure are thus minimized.

Many attempts have been made to work out by statistical methods the cash value of a high-school education. Such estimates are largely guesswork; but few persons doubt that schooling is one of the few things that is worth more than it costs, whether its price be measured in money, in effort or in self-denial.

The Rotary Clubs have had the vision to perceive that the spread of popular education is no less beneficial to the community than it is to the individual. Their methods may be profitably studied and copied in every town with a high school in which they are not operating.

Concerning Prophets

A PROPHET is without honor in his own country. The merit of his prophecies is obscured by his personality. One who observes a tree closely is intrigued by the minute and curious pattern of the bark; only those who stand at a distance can appreciate the grandeur of towering trunk and spreading limbs. The philosopher's neighbors love him because he tells a story cleverly, or hate him because he keeps a vicious dog; his philosophy does not interest them.

The verdict of posterity concerning the merit of a labor or the measure of a crime is a fair and reasonable judgment, for the thing judged has been purged of its baffling and disconcerting personality by the process of time. Posterity is happily innocent of small prejudices. The judgment of posterity is made just by time; that of contemporaries by distance.

The prophet's fame begins in a far country. There his words are accepted because of their intrinsic worth. Disciples, being eager to do him honor and willing to justify their own opinions, endow him with a character to fit the wisdom of his sayings.

Thus, while distance gives assurance of justice in the judgment of a labor it prevents a just appraisal of the character of the laborer. If the poet would know the merit of his verses let him appeal to distance and to time; but if he would know what manner of man he is let him ask his neighbors.

The distant world may get to its feet at the mention of a philosopher's name, but the philosopher's neighbor will say to himself:

"Wherein is this man great? I observe that he eats and drinks and laughs and plays as I do. He is commonplace and frequently dull. Moreover, he doesn't sound his g's, and his hair needs cutting."

The neighbor mind limits the evidence to the details most interesting to itself. The grasshopper may concede that the elephant has great strength, but when the argument is concluded will yet mutter to himself: "He can't hop, however."

If the prophet is denied in his own home the honor that is his due he is not without his compensation. For one whose wisdom is praised by all the world is in danger of becoming great in his own esteem and thus losing touch with the mass of humanity wherein his wisdom had its birth. Except the prophet be a god, the words he speaks are not his own. They are taken from the life of the people, and he is but a mouthpiece. The accumulated wisdom of the centuries is stored in the hearts of the people; a philosopher is one who has discovered a key to the storehouse. If much praise fattens his ego his source of supply will be closed against him and there will be an end of his philosophy.

The world, by its flattery, is forever tempting its great ones to make themselves ridiculous. Only the neighbors, by their steadfast refusal to join in the cheering, insure to the prophet the measure of humility necessary to encourage industry and promote good work.

RAISING BUMPER CROPS WITH POISON GAS—By Robert Crozier Long

ALMOST with the intensity of their former war interest German men of science are pursuing a new poison-gas campaign, which is to achieve what the chlorine and mustard-gas argument lamentably failed in, and put the republic at last and really *über Alles in der Welt*. Even case-hardened Germanophobes watch this campaign with sympathy. Its purpose is to raise the badly sunken crops to a level higher than that of prosperous prewar times; to double or even treble the food production; to make an at present ill-nourished people independent of foreign flour; and thereby to restore the trade balance and rescue a battered Reichsmark exchange from ever-increasing inanition. The secret of this, in Prussian professorial language, is carbon fertilization of crops; in ordinary language it is the diversion into and distribution among growing plants of carbonic-acid gas, the CO_2 of school books, a gas fatal to human beings and animals in very moderate quantities, but beneficial and indispensable to plant life. Through the application of adequate doses of this poison gas wheat ears are doubled in weight and size; rye, which in the German's daily bread plays a greater rôle than wheat, is equally increased; and on impoverished soil rise potatoes, cabbages, peas, tomatoes and fruits surpassing the prize productions of model farms. From red currants to pumpkins no fruit has been discovered that cannot be poison-gassed into extra size and nutritiousness. And all this magic, which will revolutionize agriculture and ultimately the trade of the world, will be achieved at a very moderate capital expenditure, and at practically no operating cost at all.

Carbon fertilization is in its infancy, and being an infant its brilliancy may be exaggerated. There are visionaries who already talk of onions as big as pumpkins and of pumpkins as big as balloons. They see in dreams the imaginary monstrous vegetables raised with H. G. Wells' Food of the Gods. This is an absurdity. But Friedrich Riedel, of Essen, the man who has done most to solve the problem practically, proved by convincing figures that any country's food crops may be doubled with CO_2. Naturally not at once. "Bad things," said Samuel Johnson, "wax more rapidly than good"; and if Prussia's ablest war chemists needed only three weeks to find means for poison-gassing enemies into eternity the beneficial poison-gassing of plants will need years or decades of labor before the world's food condition can be materially improved. Yet this movement is no longer merely experimental. For more than three years carbon fertilization has been successfully carried on on a great scale; and the triumphs achieved—verified by minute records and confirmed by conversion of authoritative doubters—give fair color to Riedel's prediction that within visible time a gas equipment will be as obvious a part of an efficient farm as it already unluckily is of an efficient military force.

Nature No Longer Trusted

THE dominant personalities in the new poison-gas development are three. First in time is Dr. Hugo Fischer, of Essen; first in the theory of the system is Dr. F. Bornemann, now of Heidelberg, formerly professor of farming at Berlin Agricultural High School; and first as practitioner is Riedel. As practitioner Riedel leads not only because he has gassed vegetables, fruits and grain crops on much the largest scale, but because he first made the process easy and cheap by drawing his carbonic-acid gas from the blast furnaces of great smelting works.

With all three experimenters the underlying principle is the same. This principle is that carbon is the most important constituent of all vegetable matter; and that though the deficiency of other vital crop constituents is made good as a matter of course by farmers when they apply fertilizers, the dominant question of a sufficient carbon supply is left to take care of itself. For carbon the farmer puts his trust in nature. That he does so is a paradox. For nature, as he learns in his first lessons on farming, cannot always be trusted to supply nitrogen, potassium and phosphorus in sufficient quantities; why then should nature be relied on to supply the precise, minutely rationed quantity of carbon, neither more nor less, which best fosters a luxuriant and healthy growth? In the light of pure science the paradox is increased. In the remote Carboniferous period plant life, as coal measures prove, was immeasurably richer than to-day—the biggest modern fern is a pygmy beside the Paleozoic fern—and in this Carboniferous period, physicists agree, the atmosphere was charged much more heavily than to-day with carbonic-acid gas. Abstract science has long known these facts; applied agricultural science has ignored them. It is not long since Germany's leading agricultural chemist, the late Prof. Edward Heiden, proclaimed in a practical handbook that the sufficient supplying of carbon to crops and fruits was a matter with which no farmer needed to trouble his head.

The chemical theory behind the entirely contrary practice of Fischer, Bornemann and Riedel is simple. Carbon provides the bricks and mortar of every plant, of its root, stalk, leaf, ear, fruit and seed. The water contents, which in some plant parts outweigh everything else, are here ignored. Water constitutes as much as 75 per cent of the potato, against 24 per cent nutritive organic matter, and it constitutes 13 per cent of

(Continued on Page 78)

"I Hope You'll Turn Out to be a Better Boy Than Your Brother, the Hague Conference"

RAISING BUMPER CROPS WITH POISON GAS

(Continued from Page 21)

the rye grain against 85 per cent. If both water and minerals—between 1 and 2 per cent—are left out of account, 49 per cent of the average plant consists of carbon, against 43.5 per cent oxygen, 6.3 per cent hydrogen and 1.2 per cent nitrogen. Of carbon, that means, is used forty times as much as of nitrogen, for which in the form of nitrates every farmer provides as a matter of course. Of cellulose 44.4 per cent is carbon; of lignin, the wood matter, 55 per cent; of sugar 40 per cent; of straw 45 to 50 per cent; of albumen 50 to 54 per cent; and of oils and fat actually 76 per cent. Carbon supplies from nearly one-half to two-thirds of the substance of every plant material which has value as food or in industrial use.

For growth, in addition to the four chief elements mentioned, every plant requires nine other elements. It requires sulphur, silicium, chlorium, sodium, magnesium, iron, calcium, potassium and phosphorus. Of these, with the exception of calcium, potassium and phosphorus, all soils contain enough. The practical farmer recognizes this when he applies lime, potash salts and phosphates; and having applied also nitrates he has done, he holds, his duty to the full. The duty of supplying carbon is performed, he is convinced, by the atmosphere. The quantity of carbonic acid in the atmosphere, it is true, is small. Measured by volume it is .03 per cent, or three parts in 10,000, against 78.04 per cent of nitrogen, 20.99 per cent of oxygen, .94 per cent of argon, and traces of four other gases.

That is average country air; tests taken outside Munich forty years ago showed only .02 per cent of CO_2, or two-thirds of normal; and a London December day once revealed 14.1 per cent, or nearly five hundred times the normal. At most, the quantity is small. But the quantity of CO_2 actually available for plant growth is greater than the average proportion in the air. The gas is brought down to the soil dissolved in rain, and evaporation releases it. The quantity released varies according to the height of the cloud and the slowness and fineness of the rain. The organic matter in a humous soil is continually decomposed by bacteria, worms and minute animals, and the carbonic-acid gas is set free. Organic, in particular animal, fertilizers are decomposed by the same means with the same result. Like all living cells, plant roots breathe and release CO_2. These four additional supplies of the gas play a great rôle in crop growth. The tests of Professor Bornemann show that between one-sixth and one-seventh of the carbon contained in a normal crop is derived from gas exhaled from the soil.

Plant Digestion

Plants, as every farmer knows, assimilate the atmospheric and the exhaled carbonic-acid gas, and apply the carbon therein for production of their organic substance. By the leaves the gas is decomposed into its two constituents, carbon and oxygen, and the oxygen is exhaled. The path to acquirement of this elementary knowledge was long. A Swiss, Charles Bonnet, first discovered that leaves give off a gas; Priestley, an Englishman, identified this gas as oxygen; a Swiss, Senebier, discovered that the oxygen is the rejected element of inhaled carbonic-acid gas; and Senebier's famous pupil, Theodore Saussure, member of a family which produced three first-rank scientists, developed the doctrine, and proved it by feeding plants with carbonic-acid gas. The gas enters the slit-shaped leaf pores—of which a single cabbage leaf contains 11,000,000; it is dissolved in a liquid which saturates the delicate walls of the green or chlorophyll cells; it passes, so dissolved, into the interiors of the cells; and it is here decomposed into the retained useful carbon and the superfluous rejected oxygen. That is assimilation. For assimilation three things are necessary: A living green plant substance, air containing carbonic-acid gas, and power. The power is light. Beyond that very little is known about a plant's methods of self-construction. The complicated processes by which carbon, with other materials, is worked up into cellulose, lignin, albumen, starch, sugar and fats, are not known at all. There are probable theories and plausible assumptions, but nothing more.

Without sufficient light no plant will assimilate carbon. Yet the first discovery that plant growth can be increased by an extra supply of CO_2 was made, a hundred years back, in the dim and smoky English city of Manchester. That plants do not grow well in industrial cities is not due to the excess of gas, but to bad lighting, and to sulphuric acid, smoke, dust and other impurities in the air. Saussure proved this by comparative experiments with plants in ordinary air, in air enriched with varying extra doses of carbonic-acid gas, and in pure carbonic-acid gas. Given very good lighting, he showed, plants grow best in an atmosphere containing 8 per cent of CO_2, or 260 times the normal; no light, however strong, he proved further, increases assimilation if the supply of CO_2 is insufficient; and finally, even with the strongest lighting, more than 8 per cent of the gas is injurious. A later experiment showed that the yellow light rays best foster assimilation; orange and red are less effective; and blue and violet rays produce practically no assimilation at all.

Striking Results

On the eve of the experiments of Fischer, Bornemann and Riedel no serious doubt existed that carbon fertilization was a theoretically practicable and useful help in agriculture. But the practical results were nil. Reasons for this were, first, the supposed technical difficulties and, second, the incurable obstinacy of even scientific farmers. The technical difficulty is, however, merely a commercial one, a question of operating costs versus extra crop profits. The cost of producing and distributing carbonic-acid gas on the large scale needed even for a vegetable garden would be far greater, it was believed, than the increased value of the yield; and the cost of poison-gassing whole fields of wheat, corn and oats would be monstrously out of proportion to the additional value of the crop.

Even at first sight this opinion looks like a prejudice. The same farmers who held it found it practical to pay for carriage of potash from Europe to the central plains of the United States, for carriage of phosphates for equally great distances, and for carriage of Chile niter from a remote corner of South America to a noble's estate on the slopes of the Urals. The argument that these fertilizers are abundant and need only transportation no longer applies. For seven years past the only nitrates used by German farmers have been synthetically prepared out of the atmosphere by the costly and complicated Haber-Bosch and calcium processes. There is nothing more far-fetched in adding carbon dioxide to the air than in extracting nitrogen out of it; and fifty years ago probably every farmer would have proclaimed the second plan to be the more far-fetched and visionary of the two.

The only real unsolved problem, that means, was the problem of commercial practicability, the question of supplying carbonic-acid gas at a reasonably low cost. Fischer, the first of the recent German investigators, found the problem insoluble. He therefore ignored it, and experimented only with the expensive cylinder CO_2 of commerce. He began by treating plants with air enriched to .09 per cent of gas, or three times the normal, and he ended with .66 per cent, or twenty-two times the normal. His results, always measured by comparisons with nongassed plants grown under similar conditions, were:

Greater size and weight of the plants as a whole;

Considerably earlier blossoming and ripening of fruits;

Very much bigger and richer fruits.

His last experiments, made together with Professor Bornemann, were with the ordinary German winter wheat and winter rye, which supply the greatest part of Germany's breadstuffs. These were planted both under glass and in the open. The results of gassing were in all cases good. The gassed wheat and rye produced more and stronger shoots than the ungassed, they ripened weeks sooner, and they carried

(Continued on Page 81)

(Continued from Page 78)

bigger ears. Seeds which, ungassed, yielded ten ear-bearing straws, yielded when gassed as many as thirty-two. The best results were obtained under glass, and the results with rye were better than with wheat.

Bornemann followed with independent open-air experiments, lasting 130 days, on winter wheat, oats, barley, beans and mustard. Gas was distributed from ordinary small lighting-gas pipes, which the later large-scale experiments of Riedel show to be unsuitable; and the other conditions, owing to poverty of resources, were unfavorable. The superiority of the gassed crops was less than Riedel attained, but it was emphatic. Gassing increased the yield of wheat 25 per cent, of oats 41 per cent, of barley 24 per cent, and of beans 63 per cent. Bornemann drew the conclusion that carbon fertilization is an indispensable part of really scientific farming. For commercial farming it was, under present conditions for producing and distributing gas, impracticable. The use of cylinder gas was out of the question. It was reserved for a young Westphalian engineer, Friedrich Riedel, to solve the problem commercially. Solution, he reasoned, lay in the utilization of the already existing unlimited supply of waste industrial gases. Confident of success, ignoring the gibes of certain professors of agriculture who told him that though he was a first-rate engineer he had yet a great deal to learn about farming, he set to work.

Hugo Stinnes—Prussia's Morgan, as some call him, a merchant of Mülheim, as he modestly calls himself in a Reichstag member's list—next comes on the scene. With 170 Stinnes industrial undertakings, capitalized at 5,500,000,000 marks, few German scenes can be imagined on which Stinnes does not appear. Riedel's experiments in carbon fertilization were made in connection with the Deutsch Luxemburg smelting works at Horst on the Ruhr, the first of the 170 corporations to be controlled by Stinnes and the nucleus of the vast electro-mining trust which to-day embraces most of the rest. Stinnes and his chief director Voegler granted to Riedel the use of the whole resources of the Deutsch-Luxemburg, its land, its machines, its workmen and its labor. Out of that rose the first great carbon farm in the world. The sowings and plantings were made on a grandiose scale; there were no economical obstacles of the kind that had hampered the first two investigators; and the result was a success which soon put an end to doubt in the most skeptical professorial brain.

Riedel's first work was to construct two big glass houses as near as possible to Stinnes' blast furnaces, and to prepare two fields for open-air experiments a little farther off. One glass house and one field were for ordinary cultivation; the others for cultivation in air artificially fertilized with CO_2. Minute care was taken to insure that the soil, lighting and moisture should be identical for gassed and ungassed plants. The gas was distributed from perforated tubes ten centimeters in diameter with orifices of about two centimeters in diameter, placed at regular intervals; and pressure in the tubes was maintained by electric fans. In the glass house for gassing were laid two tubes, one low down, bent into twelve-meter squares, the other higher, in shape of a main tube with radiating smaller tubes. In his fields Riedel laid perforated concrete pipes, arranged in quadrilaterals, so that equable distribution was insured in any wind.

Flue Gases Used

The gas used came directly from the blast furnaces, and contained 5 per cent of CO_2, which is less than the 8 per cent found most effective by Saussure, but is 160 times stronger in carbonic than in ordinary air. The only treatment undergone by the gas between expulsion from the blast furnaces and distribution to the plants was purification from smoke and dust. Purification from sulphuric acid was not necessary, as the iron ore is smelted with coke; and purification from carbon monoxide—CO—was needless, because this gas is harmless to plants. But as carbon monoxide is highly poisonous to human beings and animals Riedel later removed it by preliminary combustion. He remarks that as a rule this is unnecessary, as most industrial works in their own interests allow no carbon monoxide to escape.

Riedel's experience is that 5 per cent of carbonic-acid gas is the most effective on the average. But how much of this mixture is really available for the plants is not exactly known. In the open air, part of the CO_2 is speedily blown away by wind; and if there is no wind it is thinned by diffusion. In glass houses the continuous forcing in of a 5 per cent mixture under pressure keeps the whole air of the house at that strength. By that is explained the fact that in Fischer's experiments the greatest additional crop yield was obtained from plants grown under glass.

After the first year of success Riedel increased the dimensions of his experiments. He built three more glass houses and added 40,000 square yards to the area of his fields. In the new fields he laid his perforated cement tubes underground. His aim was to supply the extra dose of gas from the lowest possible level, so that it would reach the leaf pores exactly as does gas set free from the soil. This diminishes the quantity of gas diffused upwards or blown away before it is caught in the pores; and the efficiency of the fertilization is very largely increased.

Riedel's experiments embraced nearly all of the more important cultivated food plants, and also some flowers. Flower tests proved useful for study of the effects of gassing upon blossoms, and one of the first triumphs was a more than four-and-a-half-fold increase in the blooms of the heliotrope plant. In fields or in glass houses were planted—sometimes in both, and always on a sufficiently large scale to produce reliable averages—barley, potatoes, turnips, sugar beet, rape, tomatoes, gherkins, lupines, soy beans, spinach, fennel and the castor-oil plant.

Important Results

The first plantings, which covered only six of the plants mentioned, took place in 1917 in the middle of May. Four weeks later, when the first green shoots were showing above the soil, carbon fertilization began, and with it began the making of hourly and daily observations and the keeping of minute records. Within two or three days the difference between sizes and conditions of gassed and ungassed plants was seen. The difference invariably favored the gassed plants. It was at first confined to stalks and leaves; later, when blossoms and fruits appeared, the difference was equally marked; and finally the harvesting of the root and tuber crops proved that the advantage from gassing was gained by every part of the plant.

First and most important of results of gassing is the greatly increased leaf growth. The leaves of Riedel's gassed plants were larger and their stalks thicker and firmer. The leaves of mangel-wurzels gassed in the open air averaged in area 70 per cent more than the leaves of ungassed plants. Ungassed castor-oil plants had leaves 58 centimeters long; gassed plants had leaves 100 centimeters long. The gassed castor-oil leaves bore a whitish bloom similar to the bloom on grapes. Leaves of gassed plants were unusually firm and fleckless, and they were colored a deeper green, proving better assimilation and a richer production of the precious chlorophyll, the green coloring matter upon which the health of all plants, parasitic fungi excepted, depends.

This better leaf production in the early growth stage is especially important, because the leaf's ability to absorb carbonic-acid gas depends upon its size. Therefrom follows the fact—proved when Riedel interrupted the gas supply—that the young gassed plant with its abnormally big leaves extracts an extra dole of carbon also out of the ordinary air, so that carbon fertilization, even if carried on for only a few days in the early growth period, largely increases the ultimate size and weight of the crop.

Riedel found not a single exception to the rule that carbon fertilization materially increases the weight and size of fruits and roots. The smallest advantage of any gassed fruit or root crop over an ungassed crop was 15 per cent. In all other cases the advantage was at least 36 per cent; often the advantage was more than 100 per cent, and sometimes it was more than 200 per cent. These figures were for the whole crops of beds or patches of a defined size.

Riedel declares that carbon fertilization without other fertilizers promotes plant growth more effectively than all the ordinary fertilizers when these are used without artificially supplied carbon. Ordinary fertilizers, he says, used in ordinary air increase an average crop by half a kilogram per square meter, which is 18 per cent of the crop, whereas carbon fertilization applied without the ordinary fertilizers brings an average increase of 40 per cent. This is the experience in fields, where results are less favorable than under cover. If a field gets both carbon fertilization and ordinary fertilization the average increase of crop is 82 per cent.

Riedel, Bornemann and Fischer draw from this the conclusion, valuable for all farmers, that fertilization with nitrates is usually overdone, and that part of the heavy cost is needlessly incurred. The full quantity of nitrates usually used could be taken advantage of by crops; but in practice it is not taken advantage of, because the supply of carbon is relatively too small. The dissatisfied farmer, however, often adds more nitrates at a time when he should be resorting to carbon fertilization, and so helping his crops to the more active assimilation which would enable them to use an abundant nitrates supply.

At first sight this theory is of no interest to the ordinary farmer, who is not yet in a position to supply extra carbon by artificial means. But the three pioneers of the theory declare that it has a practical immediate meaning, because carbon fertilization to a limited extent is within the reach of every farmer in possession of a harrow or a spade. This limited carbon fertilization is achieved simply by insuring that the soil is well supplied with organic matter, and by keeping the surface looser than is at present the rule.

The secret of natural carbon fertilization is merely the keeping of a continually loose surface and the prevention of incrustation. Backward farmers believe vaguely that by this means they air the land, and less backward farmers imagine that they let oxygen in. The real profit from a loose and porous surface soil is that it lets the under-surface carbonic-acid gas rise freely towards the leaves. Bornemann proves from experiments lasting seventy-eight hours that the CO_2 emitted by a continually broken surface is three times as great as from an incrusted surface. The increase of crops by poison gas, it follows, is no vision of remote scientific magic; it is an aim attainable by every practical farmer at very little cost.

Carbon fertilization by artificial means on a great scale is another matter. All the three experimenters are optimistic; but they take different views as to times and practicabilities. For the present only small operations are commercially practicable, says Bornemann. Berry fruits, vines and vegetables can already be carbon fertilized with financial success. Fischer goes further. The waste gases of industry, he predicts, will soon be set streaming through young forest plantations. Riedel has no doubt that even under present conditions grain crops can be carbonized with profit. For that, he admits, the carbonic-acid gas of commerce is too dear. Of the future he says: "Just as certain as we have to-day special plants for producing electric power, so we shall some day have CO_2 works erected for the fertilization of our fields." Costly and complicated these works will be; but they will be less costly and complicated than the equipment at present needed for production of synthetic air niter.

SOME LIKE THEM COLD

(Continued from Page 19)

you was mad at me though I cannot think of any reason why you should be. If there was something I said in my last letter that offended you I wish you would tell me what it was and I will ask your pardon though I cannot remember anything I could of said that you could take offense at. But if there was something, why I assure you, Mr. Lewis, that I did not mean anything by it. I certainly did not intend to offend you in any way.

Perhaps it is nothing I wrote you, but you are worried on account of the publishers not treating you fair in regards to your song and that is why your letter sounded so distant. If that is the case I hope that by this time matters have rectified themselves and the future looks brighter. But any way, Mr. Lewis, don't allow yourself to worry over business cares as they will all come right in the end and I always think it is silly for people to worry themselves sick over temporary troubles, but the best way is to "keep smiling" and look for the "silver lining" in the cloud. That is the way I always do and no matter what happens, I manage to smile and my girl friend, Edie, calls me Sunny because I always look on the bright side.

Remember also, Mr. Lewis, that $60 is a salary that a great many men would like to be getting and are living on less than that and supporting a wife and family on it. I always say that a person can get along on whatever amount they make if they manage things in the right way.

So if it is business troubles, Mr. Lewis, I say don't worry, but look on the bright side. But if it is something I wrote in my last letter that offended you I wish you would tell me what it was so I can apologize as I assure you I meant nothing and would not say anything to hurt you for the world.

Please let me hear from you soon as I will not feel comfortable until I know I am not to blame for the sudden change.

Sincerely,
MABELLE GILLESPIE.

N. Y., Sept. 24.

DEAR MISS GILLESPIE: Just a few lines to tell you the big news or at least it is big news to me. I am engaged to be married to Paul Sear's sister and we are going to be married early next month and live in Atlantic City where the orchestra I have been playing with has got an engagement in one of the big cabarets.

I know this will be a surprise to you as it was even a surprise to me as I did not think I would ever have the nerve to ask the girlie the big question as she was always so cold and acted like I was just in the way. But she said she supposed she would have to marry somebody some time and she did not dislike me as much as most of the other men her brother brought round and she would marry me with the understanding that she would not have to be a slave and work round the house and also I would have to take her to a show or somewheres every night and if I could not take her myself she would "run wild" alone. Atlantic City will be O.K. for that as a lot of new shows opens down there and she will be able to see them before they get to the big town. As for her being a slave, I would hate to think of marrying a girl and then have them spend their lives in druggery round the house. We are going to live in a hotel till we find something better but will be in no hurry to start house keeping as we will have to buy all new furniture.

Betsy is some doll when she is all fixed up and believe me she knows how to fix herself up. I don't know what she uses but it is weather proof as I have been out in a rain storm with her and we both got drowned but her face stayed on. I would almost think it was real only she tells me different.

Well girlie I may write to you again once in a wile as Betsy says she don't give a dam if I write to all the girls in the world just so I don't make her read the answers but that is all I can think of to say now except good bye and good luck and may the right man come along soon and he will be a lucky man getting a girl that is such a good cook and got all that furniture etc.

But just let me give you a word of advice before I close and that is don't never speak to strange men who you don't know nothing about as they may get you wrong and think you are trying to make them. It just happened that I knew better so you was lucky in my case but the luck might not last.

Your friend,
CHAS. F. LEWIS.

CHICAGO, ILL., Sept. 27.

MY DEAR MR. LEWIS: Thanks for your advice and also thank your fiance for her generosity in allowing you to continue your correspondence with her "rivals," but personly I have no desire to take advantage of that generosity as I have something better to do than read letters from a man like you, a specially as I have a man friend who is not so generous as Miss Sears and would strongly object to my continuing a correspondence with another man. It is at his request that I am writing this note to tell you not to expect to hear from me again.

Allow me to congratulate you on your engagement to Miss Sears and I am sure she is to be congratulated too, though if I met the lady I would be tempted to ask her to tell me her secret, namely how she is going to "run wild" on $60.

Sincerely,
MABELLE GILLESPIE.