Of late curing yellow tobacco has become a profession for the non-Agricultural capitalist of the Guntur District and hence the number of barns is increased by hundreds every year.

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THE VALUE OF SCIENTIFIC RESEARCH TO AGRICULTURE. *

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I appreciate that it is often difficult for the layman to see any earthly use in many of the things that scientists do and talk about doing. Of what value is it to you and to me, for instance, for a man to spend his time trying to discover the workings of nature? How can a man—we are inclined to say—do any thing useful unless he works directly with the things that we all can touch and see, that we know have practical utility?

Well, when confronted by questions like that, I think of men like Faraday and Mendel and some of the scientists in the employ of the Federal Government. About a hundred years ago in England Michael Faraday was what we might call an experimental philosopher. He never concerned himself with the invention of machines. His sole aim was to learn something about the workings of nature. He discovered the principle of electromagnetic induction, and if you remember your high school science, you will recall that without that discovery we would today have no means of putting electrical energy to work for us. Without Faraday, the amazing inventions of Edison and Marconi would not have been possible, and your radio and your electric lights would not exist.

And Mendel, that cloistered Moravian monk who whiled away the hours studying plants and experimenting with the cross-breeding of varieties of garden peas—of what earthly use was all that? He did it because it interested him. But was it of any use to the rest of us? I can assure you that it was, for the principles he discovered have been employed by the plant breeders of to-day in developing more productive varieties of every plant that feeds and clothes you. Scientists like Mendel and Faraday were working in what we call pure science. They were trying to discover nature's fundamental secrets, but without thought of any practical application of their discoveries. Had some overzealous administrator tried to restrict their curiosity to some specific object, or the immediate solution of some highly practical problem, we would have been deprived, in all probability, of their great discoveries.

It falls upon another group of scientists to apply these basic principles to the pressing problems of the world and turn them to practictal account. Thus most of the scientific research in Government departments is applied science. The surprising thing, however, is that even in the field of applied science far-reaching discoveries are made, often as a by-product of the immediate task.

* (Extracted from Science, May 19, 1933)

One of the most famous examples was the discovery by scientists in the Department of Agriculture some forty years ago, that a micro-organism found in the blood of cattle is the cause of splenetic fever, and that the disease is transmitted by the cattle tick.

These scientists—by name Theobald Smith, Curtice, Kilgore and Salmon—of course had no idea of the far-reaching consequences of their discovery. They were intent on finding the cause of a cattle disease, not in discovering a fundamental principle in medicine. But that happens often in scientific research.

And at other times, a scientist may fail to solve one problem, only to solve another, unexpectedly. Not long ago some Chemists in the Department of Agriculture were examining molds—fungous growths, that is—to find one that would produce tartaric acid. Patiently they tested one after another, until they had exhausted the possibilities of 149 different molds. Finally the 150th rewarded their long search with success—but not the success they were expecting. Instead of producing tartaric acid, the 150th mold unexpectedly produced gluconic acid. This is now used in making calcium gluconate, the only calcium salt that can be injected between the muscles, without causing abscesses, treating certain human diseases. This salt used to cost 150$ a pound. As a result of this research it may now be had for 50 cents a pound.

In one way or another, I have said, every farmer in the United States is farming differently to-day because of the scientific discoveries resulting from state and federal appropriations. To be specific and as up-to-date as possible, suppose we run down the list of research achievements reported by one bureau of the Department of Agriculture for the past year. Before me is a summarised report for the Bureau of Plant Industry and among their accomplishments I find these items:

Established the superiority of five new hybrid lines of corn in Iowa tests; released, for the use of growers, two new lines of hybrid sweet corn that will be resistant to bacterial wilt; released, for the use of growers, a new wilt resistant variety of tomato, known as the Pritchard; introduced a new blackberry variety the Brainerd, especially adapted for the West and South, and also introduced three improved varieties of strawberry; developed new root-stocks for Satsuma oranges, and found new disease-resistant stocks for California grape vine-yards; introduced a new sugarbeet, U. S. No. 1, that is resistant to the costly curlytop disease, and that also greatly outyields older varieties; tested some promising new sugarcane seedlings, crosses of American and New Guinea varieties; reported distinct progress in breeding alfalfa that will be immune to bacterial wilt, developed a new variety of Egyptian cotton in Arizona.

As another part of its job, this bureau investigates the storing, handling and processing of foods. For the year under report the bureau scientists discovered among other things, that putting apples in cold storage immediately after picking almost completely prevents soft scald: that adding sulphur-dioxide to the sawdust packing of grapes retards the development of mold; and that treating fruits with carbon dioxide before shipment is as effective as pre-cooling in preventing spoilage.

That is a partial report of the research accomplishments of one bureau. It gives point to the statement that research can stabilise crop production and eliminate or reduce those hazards—of disease, of climate, even of soil—which make agricultural production uncertain. For it remains true that though drought or disease or insect pests may raise the price of a crop by reducing the supply, such higher prices are cold comfort to the particular farmer whose cotton has been destroyed by the boll weevil or whose wheat has been hit by rust. I have, I think

a proper scientific respect for insects and diseases, but I question whether we ought to leave it up to them to determine the size of our crops and the level of our incomes. Nor can I forget that every year, according to Dr. L. O. Howard, the damage wrought by insects nullifies the labor of a million men

If time and your patience permitted, it would be possible to cite instances to show how research has affected all our major farm crops and classes of live stock, how the patience, the skill and the informed imagination of scientists employed by the Department of Agriculture have altered the Agricultural map of this country and modified the farm practices of every farmer in the land. Many farmers are not aware of this, for the results of research reach the individual farm by an intricate, devious path, but they get there just the same.

If you will agree with me on that, I suspect you are at the same moment questioning whether this research has proved to be an unmixed blessing. For science and invention, you will say, have not only made it possible for us to produce enough to go around; they have made it possible for us to pole up towering surpluses, which in turn seem capable of bringing our whole economic system crashing down around our ears.

We cannot deny that when scientists in the Department of Agriculture develop a variety of wheat that produces five bushels more per acre than the variety commonly grown, one result may be, and often is too much wheat. When our modern knowledge of nutrition enables one bushel of corn to go as far as two bushels did in the pioneer days in feeding live-stock, one result may be too much pork and lard. Of late years the Department of Agriculture and the Colleges have been aware of the problem. They have tried to meet it by helping the individual farmer adjust his own production to changing market needs. They have hoped that advice and complete information on supply and demand would suffice. Where they have been remiss, in my judgment, is in declining to face the fact that the individual farmer cannot adjust his production intelligently, unless he knows, with some degree of certainty, that his neighbors will do likewise. And it is to face that fact realistically that the new farm bill has been drafted. The essence of it is collective action, by all the producers, to accommodate their production to the market that actually exists.

Our expenditures for science, our efforts at increasing productive efficiency have in no sense been unwise. Certainly no thoughtful person could approve the abandonment of scientific research, or the relegation of our machines to the ash-heap. To do that would be like abandoning the use of automobiles because we have automobile accidents. As a rule, the fault is not with the automobiles but with the driver

It is not the fault of science that we have unused piles of wheat on Nebraska farms and tragic breadlines in New York City at one and the same moment. Rather it is because we have refused to apply science to the development of social machinery, machinery that will regulate our economic system to the end that what we produce can be equitably divided.

I am not one to ask for less efficiency. I want more, and I know that we can get far more. But I want the efficiency to be controlled in such a way that it does more good than harm. I want to see the farmers of the South grow 300 pounds of cotton per acre instead of 150 pounds, and the farmers of the North 50 bushels of corn per acre instead of 35 bushels. I want to see the average milk cow yield 400 pounds of butter fat per year instead of 200. And I see no reason why our hogs eventually should not produce 100 pounds of pork on the average from 6 bushels of corn, instead from 9 bushels.

These things can all be done. The research now going on will make it possible, and will pave the way for countless new agricultural achievements as well. Only the other day I learned that research now in progress indicates that crops grown in some regions of the nation have a higher nutritional value than apparently similar crops grown in other areas. If further study bears this out, the consequences will certainly be far-reaching. We may have a new agricultural map a decade from now. The research job, far from being done, is only well begun. We shall need new varieties of cereals and grasses to resist diseases better than those we now have. We shall have to keep cutting costs of production by increasing yields per acre. Methods of cultivation, like methods of feeding and managing live-stock, must be subject to continuing investigation if we are to keep abreast of the continually changing economic world about us.

When our Chemists, not long ago, discovered an economical method by which bagasse, a sugarcane waste, could be made into high quality cellulose, suitable for rayon, we patted ourselves on the back for an achievement of considerable importance. But over in the Bureau of Chemistry and Soils is a small bottle of a brownish cellulose substance called lignin, which was derived from the corn plant after many years of experimentation. The chemist will tell you that lignin is one of the principal parts of woody plant tissues; that it can therefore be obtained in abundance and it may yield a startling new collection of products. Already he has discovered in lignin such compounds as phenol and creosol Lignin may yet rank, in its rich potentialities, in its influence on disposing of farm wastes, with our major chemical discoveries.

No, the job of scientific research in Agriculture is not over, nor will it ever be. But to-day we have a new job a new field for experimenting—that of social control. Research to increase productive efficiency, to widen markets, must continue. Eliminate the less important research activities, in deference to the need for economy; get rid of the dead wood in our scientific organizations—but keep the men of science at the tasks which will always need doing. And add to the old job the one that has been begun so well, this new job of developing the machinery of social control.

Notes and Comments

I. **The Problem of unemployment.** We commend to our readers two schemes proposed to solve the problem of unemployment. One is that of the Director of Agriculture, Bengal, and the other a similar one from the Director of Agriculture, Mysore. The Bengal scheme instituted in 1928 at the Government Agricultural Farm, Faridpur provided for the employment and training of twenty educated middle class young men of all castes. These were taught the ordinary avocations of an average Indian agriculturist on a scientific basis. They were paid twelve rupees a month. Treated as ordinary farm labourers, they are required in all respects like the other farm-labourers to perform with their own hands all such operations as ploughing, laddering, weeding, jungle cutting, carrying baskets of manure, cleaning cattle-sheds, transplanting paddy in mud, cutting and steeping jute and extracting fibre therefrom for which operation they had to stand in water for hours together. They were not permitted to draw any allowance from their homes, although all of them invariably belonged