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Lionel K. Arnold  
*Iowa State University*

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## Increase Industrial Uses of Farm Products ?

A chemical engineer at Iowa State looks at the possibilities and problems of increasing the industrial use of farm products. While effects might not be immediate, he says, such use could be effective over time.

by **Lionel K. Arnold**

**T**HE FARM PROBLEM — surplus production and low farm incomes compared with incomes in other parts of the economy—isn't new. But it has become more obvious and serious in recent years.

The temporary farm prosperity brought about by the Korean conflict ended by 1953, reminding the nation that the farm problem still existed. As outlined earlier in *IOWA FARM SCIENCE*: "Increasing evidence has indicated that agriculture is (and has been for some time) out of balance or adjustment with the rest of the economy. Returns to resources in agriculture have been declining. The national economy has been growing, but agriculture hasn't been sharing fully in the fruits of this growth."

Basically, this appears to be a problem of overproduction and resource use. As pointed out in the report of the Commission of Increased Industrial Use of Agricultural Products to the 85th Congress:

"American farmers have succeeded so well in the necessary effort to increase their efficiency that they now consistently outrun the capacity of the economy to consume what they produce.

"To cope with this situation, which has widespread disrupting effects on markets, Government has resorted to costly programs for restricting land use, controlling production, and disposing of surpluses.

"Though population is growing and living standards are rising, the productive capacity of our agriculture promises for many years to keep increasingly ahead of both.

LIONEL K. ARNOLD is professor of chemical engineering, Engineering Experiment Station at Iowa State.

"An increase in exports seems unlikely as other countries become more and more self-sufficient.

"It is widely agreed that American agriculture should for many reasons be kept at high levels of production and efficiency. Since there seems to be little prospect of a sufficiently large expansion of food markets in the next decade to use all the excess, the question becomes:

"Can the economy develop profitable industrial markets capable of absorbing enough of the excess farm production to minimize, possibly even to eliminate, the need for costly restrictions, supports, and surplus disposing operations?"

### Industrial Uses?

From the standpoint of the chemical engineer, it appears that it should be possible to do much to develop industrial markets for farm surpluses. Farm surpluses are basically chemical raw materials — cellulose, starches, sugars, fats and proteins. As chemical raw materials, they could well be the starting point of a wide variety of industrial products with many uses.

While many of the possible products are known to chemical engineers and chemists, the development of these products and of yet unvisualized products will depend mainly on research to point out their potential uses to industry. The Commission's report had this comment:

"With few exceptions materials from the farm have not had the intensive and systematic laboratory attention that has been given to those from other sources. When utilization research in agriculture has had the benefits of adequate expenditures and large teams of workers, the results have been outstanding—as in the case of commercial methods for producing penicillin, frozen concentrated fruit juice, nylon from corn cobs, various products from soybeans."

It isn't enough, however, just to know what products might be made from agricultural materials. In most cases, these involve the operation of a new process—calling for an outlay for new equipment in the face of the usual uncertainty as to details of operation and profit. The potential profits must be higher than the known profits of the old process if they're to be attractive to the manufacturer. It's also necessary that there be a reasonably constant supply of the material available in both the short and long run.

Processing industries—because of their relatively high investment and low profit margins — usually must operate substantially all of the time to show a profit. Remember that the manufacturer, like the farm operator, is in business to make money and can't be expected to invest money in a new factory without some assurance of a profitable return on his investment.

It's important also that the new products made from agricultural raw materials don't simply replace older products made from the same or other agricultural raw materials. A mere shift in the end product being marketed doesn't necessarily benefit the farmer. The new uses which would benefit agriculture will probably be in the nonfood field since it's difficult to increase per-capita food consumption.

Another point to keep in mind is that there are some products which it would be foolish to attempt to produce from agricultural materials since they can be pro-

duced more cheaply from other raw materials.

Any extended industrial use of farm products will involve chemical and physical changes of some sort. It may involve the isolation and production of constituents of the products.

Zein, a corn protein, for example, has been isolated and made into fibers. This involved the development not only of methods for separating the zein but also of methods of dissolving, extruding into fibers and hardening, as well as necessary studies on dyeing and weaving it into fabric.

Extensive industrial use might also involve the use of existing products of farm origin in manufacturing new products. It's known, for instance, that many complex organic compounds can be produced by starting with corn starch as a raw material and reacting it with various chemicals. Among the possibilities here are such products as plastics, plasticizers, films and fibers.

Or, industrial use might involve the substitution of an agricultural product as a raw material in place of another raw material for a well-established final product. An example of this is the use of furfural—a product from oat hulls and corncobs—in place of some of the petroleum derivatives originally used in the manufacture of nylon.

So no exact pattern can be set up for carrying out the necessary research and development. But we can outline a general line of attack.

### **What's Needed . . .**

First, we'd need to secure the basic fundamental data. This would include analyses of the raw materials and determinations of the physical and chemical characteristics of the various constituents. Many of these data are available but need to be gathered together, systematized and evaluated. Other data still need to be determined.

The next step would be a critical examination of the data to see whether any of the constituents might be suitable either as commercial products outright or as the raw materials for possible commercial products. The possibility

of separating this constituent and the probable cost of such separation must then be considered. The possibility of use must be thought of on the basis of the costs and supplies of the raw materials in the short and long run, the processing costs and the sales values of the resulting products.

The third step would involve small-scale separation and conversion into the proposed products with further and more definite checks on the probable economics of the procedure.

The fourth step would be commercialization. Before designing and putting the new process into operation, it may be necessary to carry out pilot-plant studies on part or all of the process to determine the costs or to design equipment. The need for pilot-plant work depends partly on the amount of accumulated experience with similar operations and on whether standard equipment can be used or whether entirely new equipment must be designed.

Sometimes large-scale pilot plants are operated to furnish samples for customer evaluation. Before building the final plant, a complete survey of probable markets based on supplying the product in the amounts and at the prices indicated by the earlier studies should be made.

### **Different Crops . . .**

In addition to potentially greater use of existing farm products, it may be possible to use some of the acreage now producing surplus crops in growing new crops which can be used industrially. This would call for combined work and development by both agriculture and industry. A current example of such a crop is the soybean.

The soybean was introduced into the country from Asia by government plant experts and was developed into a practical crop by other USDA and state experiment stations experts. The development of methods for extraction and use of the oil was done largely by the chemists and engineers of the vegetable oil industry.

Between 1924 and 1957, the acreage planted to soybeans in the United States increased by more

than 20 million acres. The resulting oil did produce competition for other domestically produced fats. But this competition was largely offset by reductions in imports and an increase in exports of fats. The soybean meal, produced as a co-product with the oil, provided the protein supplement needed for an expanding livestock industry.

A related area for research is in the development of new varieties of existing crops that are superior to the present varieties for industrial use. An example of this is the development of "waxy" corn with starch composed entirely of amylopectin, the branched-chain fraction of ordinary starch. This starch is used in certain adhesives, special food products and in textile printing. About 30,000 bushels of this corn were produced last year.

Another new development is a corn with starch high in amylose, the straight-chain fraction of ordinary starch. The amylose fraction of the starch appears to have commercial possibilities in the production of films and fibers. This new variety of corn may be commercial as early as 1961.

### **Who Would Do It?**

Any comprehensive research program covering studies on industrial use of farm products as well as the development of new crops with industrial applications brings up the questions of who will do it and how it will be financed. The commission quoted earlier proposes financing by the federal government and over-all control by a new federal commission which would allocate problems and funds to existing research organizations—such as government, college and industrial laboratories.

Properly carried out, such a program could be very effective over time. But the commercialization step, either with or without a pilot plant, would need joint engineering and industry cooperation. This phase might be completely financed by an interested industrial organization, whether carried out by an independent laboratory or in the laboratories of the industrial organization itself.