# Some Potential Industrial Opportunities in the Utilization of Agricultural Wastes in Alabama

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## Contents



## ABSTRACT


The following information is included in this paper:

(1) Some of the industrial products that might be made from Alabama waste products are enumerated.

(2) Flow sheets indicating the processes involved are included.

(3) The practical, technical, and economic aspects of many of these processes have been considered briefly.

(4) The relation between the mineral resources of the State and technical processes employing agricultural wastes and the relation between the finished products made from agricultural wastes and the old, well-established industries of the State have been shown by suitable flow sheets.

(5) It appears that a considerable number of the processes discussed might be applicable in Alabama, and that an industrial development based partly or largely on agricultural products and waste products might be possible in Alabama. However, it should be mentioned at this time that all industrial processes require considerable expenditure for necessary building and equipment. The processes described are no exception to this rule.

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## INTRODUCTION

THE ESSENTIAL raw materials for industrial manufacturing process consist of (1) mineral resources and (2) agricultural products.

Industrial development in Alabama, with the exception of the textile industry for which the raw materials are mainly cotton or rayon, has depended largely upon the mineral resources.

In several states, considerable industrial development employing agricultural wastes has taken place. It is believed that possibilities for development of this type exist in Alabama.

The first purpose of this paper is to call attention to some of the chemical and industrial materials that might be made in Alabama from various agricultural wastes. No effort has been made to list **all** the possibilities, and no doubt important possibilities have been omitted. Products that are recovered in minute amounts or by complicated processes are in most cases purposely omitted.

The second purpose of this paper is, where possible, to provide certain preliminary economic, statistical, and cost data which may be of value in determining which of these products might have commercial possibilities in Alabama. This information may be of value in deciding which process should be studied in more detail by the reader.

## CLASSIFICATION OF AGRICULTURAL PRODUCTS

Agricultural products might be conveniently classified as (1) main products (2) by-products or waste products.

Certain agricultural products are raised partly or largely for conversion into chemical or industrial products. These include cotton, employed chiefly in the textile industry; peanuts, a source of peanut oil, and peanut meal used as a cattle food; corn, a source of corn oil, protein, starch, glucose, and alcohol; sweet potatoes, now being studied in Alabama as a source of starch; sugar cane, a source of sugar; the Tung tree, a source of Tung oil that is important in certain types of paints and varnishes; soya bean, a source of soya bean protein and soya bean oil; and similar products.

Considerable progress has been made in the South and in Alabama in the industrial utilization of products of this character. A good discussion of developments along this line is given in the *Proceedings of the Second Dearborn Conference of Agriculture, Industry and Science,* printed by the Farm Chemurgic Council and the Chemical Foundation, Incorporated, 654 Madison Avenue, New York (1936).

From the second point of view, i. e., by-product and waste-product recovery of agricultural products, apparently many opportunities exist for industrial development in Alabama. Various chemical and industrial uses that have been developed for agricultural wastes are given in the following sections.

## UTILIZATION OF AGRICULTURAL WASTES

An abundance of cotton permits the production of rayon, explosives, and decorative lacquers. Cotton by-products or wastes have many uses. From cottonseed oil may be produced salad oils, synthetic lards and other edible products. From the cottonseed hulls a sugar (xylose) has been produced which has several specific uses. From this product, a compound known as furfural is easily made. This has many of the uses of formaldehyde and is now produced in car-load lots from oat hulls. The residual cottonseed hulls, after removal of the xylose, have been converted[1] into a good grade of decolorizing carbon. Carbon of this type is used for color removal and purification of sugar, glucose, and many other products.

Various uses have been suggested[2] for corn stalks and corncobs. The former has been converted into wall board, artificial lumber, paper, rayon, nitrocellulose, oxalic acid, xylose, charcoal, acetic acid, and a hard rubber substitute (Maizoleth). Corncobs can be destructively distilled, and it is claimed that the cobs have many advantages over wood for this purpose. The products recovered are gas, alcohol, acetic acid, and charcoal. Other products derived from corncobs include xylose, plastics, and paper pulp. In addition, the ground cobs are substituted for cork in making linoleum, plaster board, and decolorizing carbon. Waste straw from oats, rye, wheat, and rice has been utilized[2] in various ways. A straw board, for instance, has been made from straw of this type.

Even peanut hulls have been utilized, pure cellulose having been recovered from this material which may be converted into paper, rayon, and cellulose nitrate.

In recent years cellulose-bearing materials (agricultural wastes) have been decomposed by certain bacteria and converted into valuable products. Acetic acid, lactic acid, alcohol, methane, and hydrogen have been produced in this way.

An important industry has been established on the use of the residue from the sugar cane industry, i. e., bagasse. This has been converted into a fiber board that is widely used in the building industry.

Oat hulls have been utilized for the manufacture of furfural, which is considered to be the cheapest aldehyde available. Giving most of the characteristic reactions of aldehydes, a number of rather important uses have been developed for furfural, one of the chief of which is as a refining agent for lubricating oils.

Considerable work has been done in the utilization of soya bean oil and press cake, the latter being rich in protein. Use of soya bean press cake as a food, sizing material, and in the manufacture of glue has been suggested.

Protein waste from corn has been suggested for paints, artificial leather, and plastics. Plastics and cloth similar to wool have been made from casein of milk.

Low-grade citrus fruits (culls) have been employed as a source of citric acid.

A flow sheet for the utilization of typical agricultural wastes is shown in Chart I.

The utilization of additional agricultural wastes is discussed under the heading, "Utilization of Waste Wood."

## UTILIZATION OF WASTE WOOD AND RELATED PRODUCTS

The lumber industry is of major importance in Alabama. In the conversion of a tree into lumber the waste is very great, less than half of the weight of the tree being converted into lumber. The resulting wood waste might be utilized in a variety of ways.[3] Sawdust and shavings have been used alone as a fuel or they may be mixed with coal. Efforts to briquette sawdust with or without a binder have been fairly successful. An improved type[4] of sawdust briquette made without a binder has a heating value almost equal that of coal. Mechanical uses for sawdust and shavings include bedding for cattle, flooring compounds, various molded articles, artificial wood, wood flour, and as a filler for concrete, stucco, etc. Chemical methods for utilizing sawdust and shavings consist of distilling these materials in a closed retort, thereby recovering charcoal, acetic acid, tar, and gas.

The coarser forms of sawmill and factory wastes have many uses. "Hogged" fuel is employed in many large sawmills, and the coarser wood is used for laths, shades, chairs, matches, boxes, and crates. Wood "flour" is made from slabs or sawdust. Much of the coarser wood is now converted by the Mason process into a fiber board. In addition, considerable paper is made from the coarser forms of wood waste. Rosin is recovered from much of the soft-wood waste by extraction with a solvent. In some cases this is a profitable industry.

Several interesting methods for utilizing waste wood have been developed recently in the West. (See "Proceedings of Second Dearborn Conference of Agricultural Industry and Science," p. 194, published by the Chemical Foundation, Incorporated, 654 Madison Avenue, New York.) For example, sawmill waste has been shredded and stirred into a slurry consisting of waste magnesia and sulphuric acid, and the whole has been converted into an insulating board. The magnesia is recovered by the Cottrell process from the stacks of calciners, while the acid is made from waste smelter gases. Another process consists of the production of artificial logs by briquetting sawdust at high

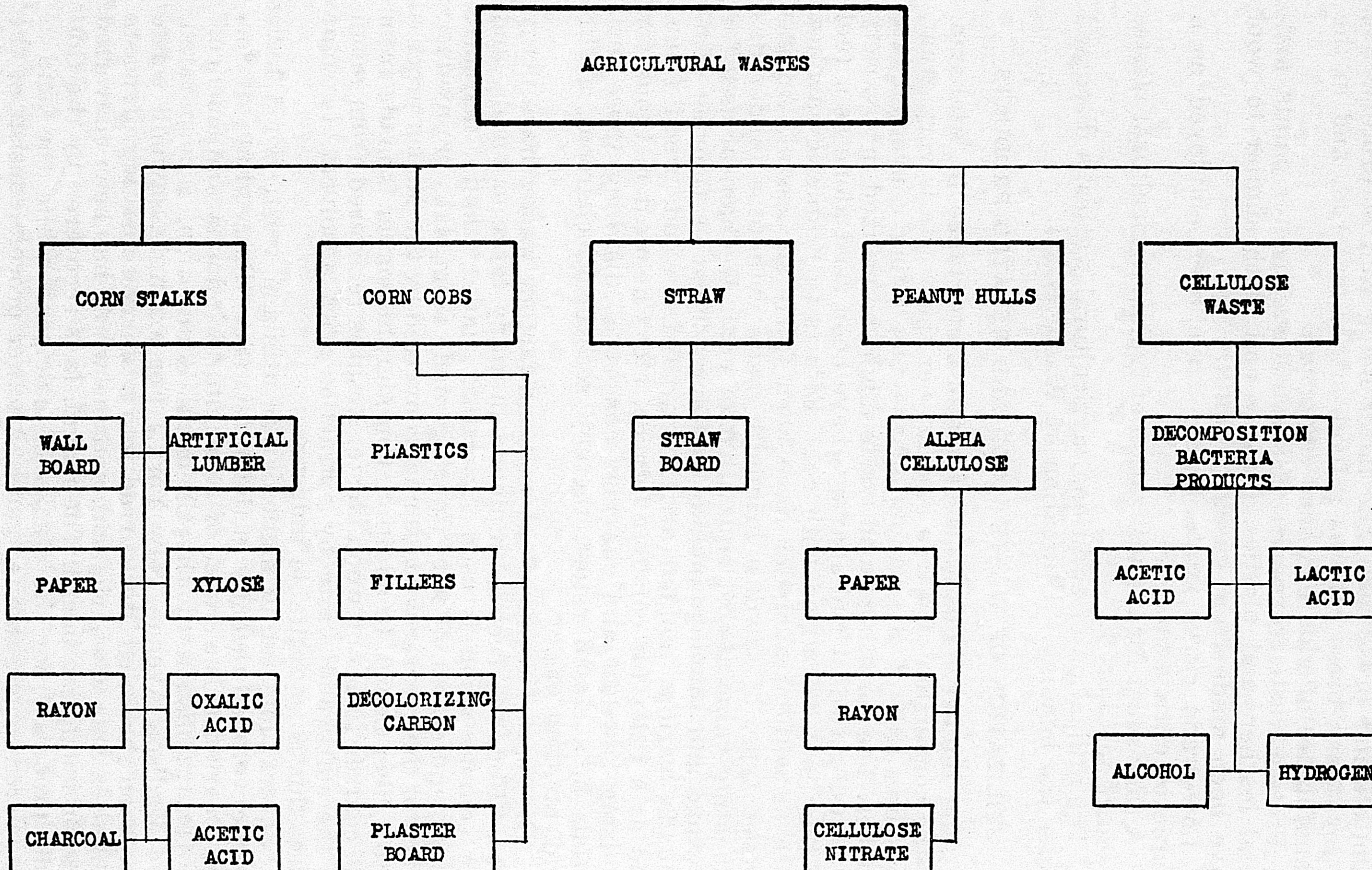


**Chart I.—Typical Agricultural Wastes and Their Utilization.**

pressures. The surface is water-proofed and other chemicals are added which impart various colors to the flames as the logs are burned in open grates.

Another interesting development mentioned in the "Proceedings" refers to the transformation of low-grade lumber into a high-grade product. The knots are punched out, the inferior portions cut out with a saw, and the removed portions are replaced and glued. By this method lumber worth $18 is transformed into a high-grade lumber worth $29 to $32.

Several methods have been developed for the production of resins from wood. (See page 196 of the "Proceedings".) One of these that apparently has possibilities consists of heating mixtures of wood, hydrochloric acid, and phenol, and drying, grinding, and reheating the product under pressure. It is claimed that the resulting product has excellent electrical insulation properties and that it can be converted into molded forms, panels, and floor tiles.

Even bark has been utilized[3] to advantage. The barks of chestnut, oak, tan oak, and hemlock are used for the recovery of tannin. Bark is now used for paper of a certain type, roofing felt for asbestos shingles and as a sound deadener. Ground bark is said to be used as a substitute for wood flour and ground cork.

Lignite, originally derived from wood or vegetable matter, is found in large quantities in the southern part of the State where its utilization as a fuel might promote industrial development in that part of the State. An inexpensive method[5] of briquetting this material whereby the quality of the lignite is increased has been reported recently by the Engineering Experiment Station of this Institution.

Many of the long leaf pines grown in large quantities in the State furnish considerable quantities of rosin and turpentine. Consequently, rosin, turpentine, pine oil and other naval stores are available for investigation. Chemical opportunities for the development of these products include the recovery of pure abetic acid from rosin, and the conversion of turpentine into artificial camphor. The availability of rosin, turpentine, Tung oil, peanut oil, etc., permits the establishment of a paint and varnish industry of major importance in the State.

The production of a good-grade white paper by Dr. Charles Herty from the slash and loblolly pines, which grow in abundance within the State, has passed through the experimental stage and is now thoroughly established.

The wide variety of native woods, some of which supply considerable quantities of naval stores, and the abundance of wood wastes from the important lumber industry offer good opportunity for the conversion of these wastes into valuable products.

Possible methods for utilizing waste wood are shown in Chart II.

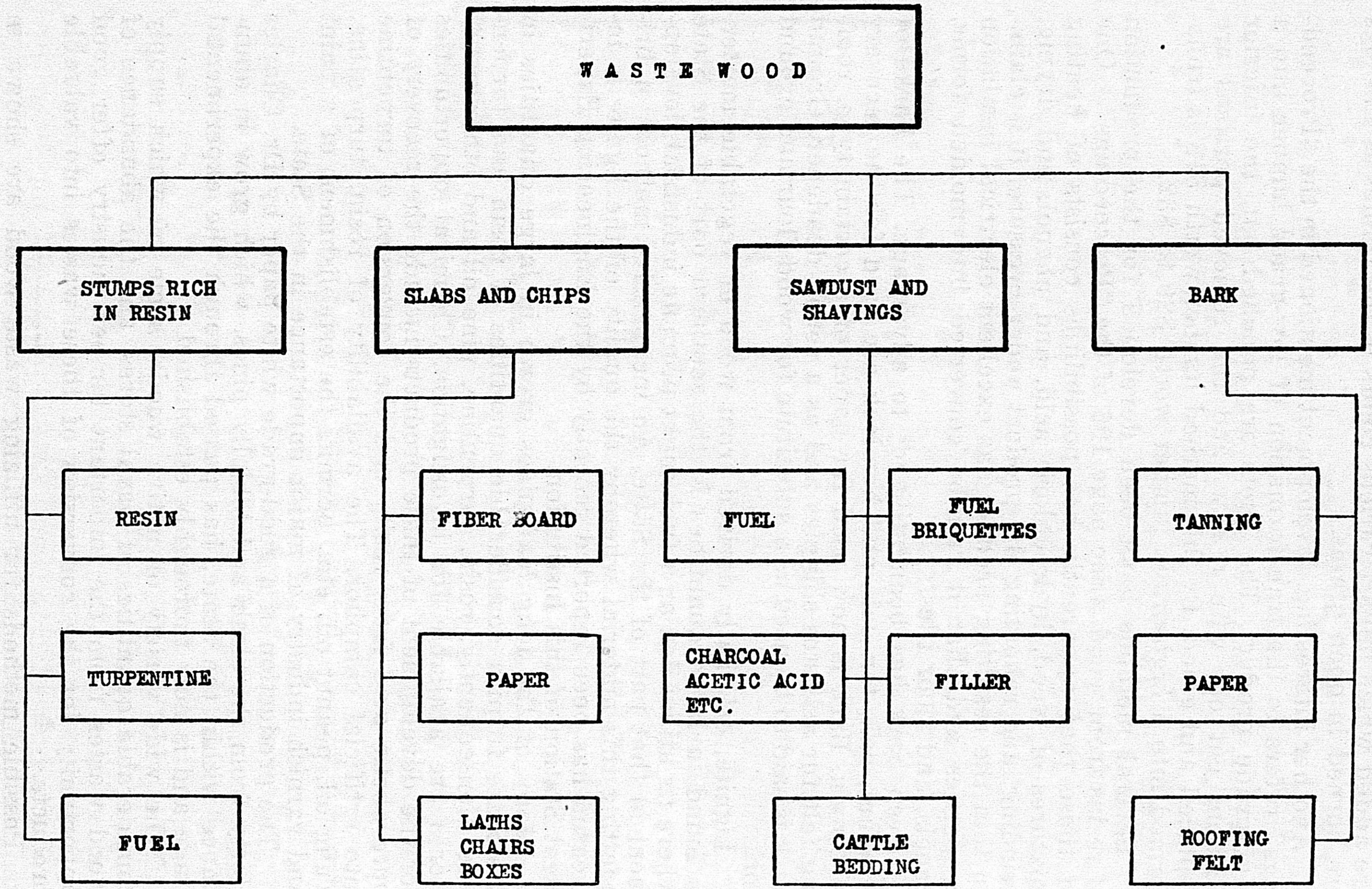


**Chart II.—Utilization of Waste Wood.**

## NOTES ON THE ECONOMIC AND INDUSTRIAL ASPECTS OF THE VARIOUS PROCESSES

Like all chemical manufacturing processes, considerable capital is required for the necessary buildings and equipment. This is a first prerequisite.

Further, as in every new chemical enterprise, it is necessary to make a careful study of the abundance, availability, and uniformity of the raw materials, as well as labor conditions, transportation facilities, markets, and other conditions.

No effort has been made to determine in detail the feasibility of any particular process, but the following comments may be helpful: According to Bulletin 98[6] of the Engineering Experiment Station of Iowa State College, Ames, Iowa, by O. R. Sweeney and L. K. Arnold, the average yield of field-dried corn stalks in the Middle West is 2.22 tons per acre. The total cost of harvesting and baling corn stalks is given as $3.31 per ton when cut by hand and $3.26 per ton when cut by a corn shocker. The cost of hauling stalks under Iowa conditions with the usual farm equipment is given as 20 cents a ton mile. It is reported in Illinois that by employing a truck and trailer this cost has been reduced to eight cents a ton mile.

Professor Sweeney[7] (address delivered in 1927—"Greater Industrial Development of Iowa by More Intensive Utilization of Agricultural Wastes") states that the probable value of corn stalk wall board is $40 per 1,000 square feet. He states that if $7 per ton is paid farmers for the stalks, the wall board can be produced for $18 per 1,000 square foot. He calculates that 4,500 square feet of board can be produced per acre. On this basis, he estimates the profit would be $99 per acre. At the present time corn stalk wall board is being produced commercially. In the above address Professor Sweeney also states that almost any grade of paper can be made from corn stalks. The problem is said to reduce itself to a cheap collection of the stalks. According to the same address by Professor Sweeney a company at Indianapolis, Ind., has built a plant for destructive distillation of corncobs. Reports in 1927 were that it was working successfully.

A corn stalk acoustical board is reported in Bulletin 137[8] of the Iowa Engineering Experiment Station by Arnold Plagge. Few economic data are given.

According to a bulletin[9] of the U. S. Department of Agriculture, entitled "Farm Wastes for Paper and Board Making," published in 1929, corn stalks, straw, etc., have both advantages and disadvantages for paper making. Many essential data relating to cost of paper making equipment and necessary buildings are given.

The recovery of furfural in car-load lots from oat hulls has already been mentioned. Considerable work has been carried out in Alabama by the Alabama Polytechnic Institute, the University of Alabama, and the Federal Phosphorous Company on the recovery of xylose, a five-carbon sugar from cottonseed hulls. This product was recovered successfully on a semi-plant scale and the general opinion apparently was that it has possibilities. At the Alabama Polytechnic Institute, the residual hulls after extraction of the xylose, were converted into a good grade of decolorizing carbon. The reports of this work appear to be promising, and are given in Bulletin 2 of the Engineering Experiment Station of the Alabama Polytechnic Institute, Auburn, Ala., by C. A. Basore and W. K. Schweikhardt.

As far as waste wood is concerned, the use of the coarser forms of wood waste for laths, furniture, etc., and sawdust and shavings as a fuel, are well understood. According to Mr. Ben Fogler[10], large quantities of sawdust and shavings are converted into wood "flour." One year as high as 85,000,000 pounds was used in industry as a filler in the manufacture of linoleum, in explosives and in the plastic industry. According to Mr. Fogler the prices quoted on wood flour normally range from $23 per ton to $50 per ton. Mr. Fogler states that in the selection of suitable locations for the manufacture of wood flour the most important considerations are the cost of the raw materials, power, and transportation costs. The cost of freighting sawdust or shavings even a few miles is an important item.

Various efforts have been made to produce a satisfactory fuel briquette from sawdust and shavings. A method[5] which gives a fuel briquette with a heating value (10,500 B.T.U. per lb.,) nearly as high as that of some coal, is described in Bulletin 1 of the Engineering Experiment Station of the Alabama Polytechnic Institute by C. A. Basore. The estimated cost is $1.64 per ton.

This discussion would not be complete without mention of the Mason process for converting the coarser forms of wood waste into a pressed board. This board is being produced commercially and apparently is very successful. This process probably is patented.

## MINERAL RESOURCES OF ALABAMA THAT MIGHT BE USED IN THE MANUFACTURE OF CHEMICAL PRODUCTS FROM AGRICULTURAL WASTES

Many of the numerous mineral resources of the State might be used to good advantage in the manufacture of various products from agricultural and wood wastes. For example, the manufacture of paper requires water, limestone, fuel, etc. Rayon requires carbon, sulphur and water, most of which are found in the State. Oxalic acid requires lime and water, and sugar requires water, lime, carbon dioxide and phosphates, all of which are available in Alabama. Paints and varnishes require fillers such as barium sulphate or calcium carbonate, dryers such as manganese dioxide, and pigments such as ochre, carbon, etc., all of which are available in Alabama. Because of the abundance of minerals closely adjacent to the agricultural dis-

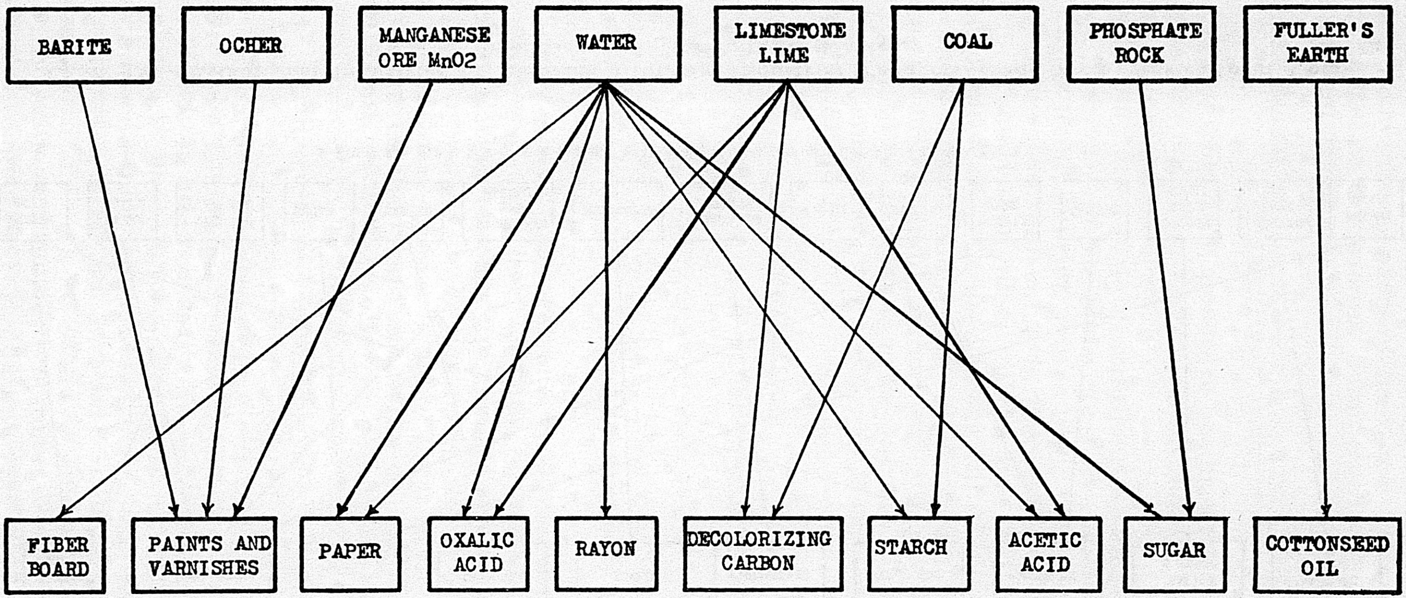


**Chart III.—Typical Examples of the Utilization of Mineral Resources of Alabama in the Manufacture of Industrial Products from Agricultural Materials and Agricultural Wastes.**

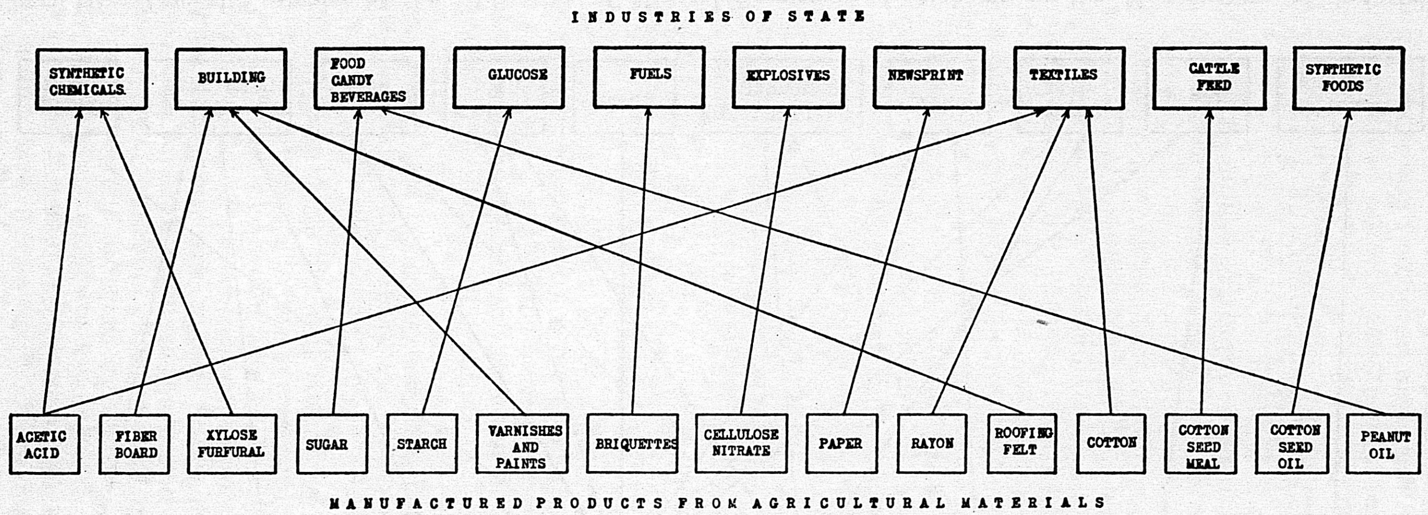


**Chart IV.—Established Industries of Alabama Utilizing Industrial Products Made from Agricultural Commodities and Agricultural Wastes.**

tricts, it seems probable that most of the minerals needed could be provided within the borders of the State, thus reducing transportation charges to a minimum. The possibilities along this line are summarized in Chart III.

## PROBABLE MARKET FOR MANUFACTURED PRODUCTS FROM AGRICULTURAL WASTES

Many of the industrial products produced from agricultural wastes probably could be used to good advantage in other industries of the State.

Examples of the possible utilization of such products in the established industries of the State are given below. White paper might be used for newsprint, paper bags, boxes and similar articles. Rayon would be of value in the textile industry. Masonite and fiber board find place in the building industry. Varnishes and paints would be used in the building and automobile industry. Scrap wood would be of value for laths and furniture, and in the cement and linoleum industries as a filler. Decolorizing carbon would be of value in removing the color from sugars, phosphate and similar solutions. Various illustrations are shown graphically in Chart IV.

## CONCLUSION

The work covered in this paper might be summarized as follows:

(1) Some of the industrial products that might be made from Alabama waste products have been enumerated.

(2) Flow sheets summarizing the possibilities along this line have been included.

(3) The practical technical and economic aspects of many of these processes have been considered briefly.

(4) The relation between the mineral resources of the State and technical processes employing agricultural wastes and also between the finished products made from agricultural wastes and the old well-established industries of the State has been shown by means of suitable flow sheets. Apparently many of the mineral resources of the State might be employed in the production of products from agricultural wastes, while these finished products, in turn, apparently might be used advantageously in established industries of the State.

(5) It appears that a considerable number of the processes discussed might be applicable in Alabama, and that an industrial development based partly or largely on agricultural products and waste products comparable to that experienced by some other states, might be possible in Alabama. Before this question can be answered definitely in the affirmative for any particular product or processes, a more exhaustive and intensive study will be necessary by those interested in such products or processes.

## REFERENCES


1. Basore & Schweikhardt—"A High Grade Decolorizing Carbon from Extracted Cotton Seed Hulls"—Bulletin 2, Engineering Experiment Station, Alabama Polytechnic Institute, Auburn, Alabama.

2. Basore—"Agricultural Wastes and Industry"—Manufacturers Record, November 5, 1931.

3. Basore—"Putting Wood Wastes to Use"—Chem. Met. Eng., Sept., 1931, p. 543.

4. Basore—"Fuel Briquettes from Southern Pine Sawdust"—Bulletin 1, Engineering Experiment Station, Alabama Polytechnic Institute, Auburn, Alabama.

5. Basore—"Fuel Briquettes from Alabama Lignite"—Bulletin 8, Engineering Experiment Station, Alabama Polytechnic Institute, Auburn, Alabama.

6. Sweeny & Arnold—Bulletin 98, Engineering Experiment Station, Iowa State College, Ames, Iowa.

7. Sweeney—"Greater Industrial Development of Iowa by More Intensive Utilization of Agricultural Wastes"—address delivered in 1927. See Engineering Experiment Station, Iowa State College, Ames, Iowa.

8. Plagge—Bulletin 137, Engineering Experiment Station, Iowa State College, Ames, Iowa.

9. U. S. Dept. of Agric.—Bulletin, "Farm Wastes for Paper and Board Making," 1929.

10. Fogler—"Utilization of Wood Waste in the Chemical Industries" — Arthur H. Little and Company, Cambridge, Massachusetts.

11. Proceedings of Second Dearborn Conference of Agricultural Industry and Science, published by the Chemical Foundation, Inc., 654 Madison Ave., New York.