Research on New and Extended Uses for Cotton[1/]

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In the case of any commodity, the people of the country in which it is produced almost invariably consider that commodity from what might be called a selfish standpoint. That is, if the people producing some particular commodity are in a favorable economic status, well and good; if they are not, an attempt is made to remedy the situation, and this attempt has usually been made independent of any consideration of possible effects on the producers of this commodity in other countries. This is only a natural trait of human nature. Of course, in many instances such a procedure has been the simplest and most satisfactory from the standpoint of all concerned; but where the commodity in question is one of economic importance in several countries, and where the commodity is an important medium of international trade, mutual understanding and international planning is often desirable, and sometimes necessary before a satisfactory solution can be obtained.

The case of cotton fits very well into this latter category. Others in this conference will discuss the international phases of the cotton problem. I want to discuss one line of activity being pursued more or less independently in various cotton-producing and cotton-consuming countries but which is always carried out on the basis of keen but friendly competition:- Scientific and technological research on the utilization of cotton. Naturally, our research is centered around the types of cotton which are grown in the United States, but the methods employed are of general application and you may find parts of our research program of interest in connection with some of your own cotton problems.

I shall not describe the economic background of the need for research to find new and extended uses for cotton. For decades there have been leaders, both in and out of the industry, who have pled strongly and worked tirelessly for a broad and intensive research program to prepare the industry for the inevitable competition from other textiles and other products. These efforts are beginning to have results. Many organizations of a private, public, and semi-public nature are now undertaking research to increase the utilization of cotton and cotton products.

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It is generally recognized that large scale, carefully planned, intensive research is necessary if cotton is to hold its prominent place in the future. One has only to observe the increasing competition to lint cotton from paper and synthetic fibers, and to cottonseed products from other oils, and protein, to realize the truth of this statement. The present war prosperity, shared in full by all branches of our cotton industry, tends to obscure the real condition of this industry. When the war is over, competition from other fibers and products will be intensified beyond any measure experienced heretofore.

What are the essentials of a program of research to develop new and extended uses for cotton? The procedure involved in this type of research is quite straightforward, and its effectiveness is limited only by the extent of man's ingenuity. There are three principal steps in this procedure: first, the determination of permissible cost and the basic physical and other requirements of the particular use being studied; second, the experimental development of a product designed specifically to meet the requirements of the use; and third, laboratory and service testing to determine whether or not the experimentally developed product meets all of the use requirements. Repetition of these steps, where necessary, finally leads to the development of a satisfactory cotton product, or to a reliable conclusion that such a development is not feasible, within the present growth of the industry.

Although it may seem obvious that such a procedure is the logical method to be followed in developing new and improved cotton products, this has not been the general procedure in the cotton industry. However, there have been a few notable exceptions which definitely establish the effectiveness of this type of research. Tire fabric is an outstanding example of a cotton product, which, during its entire history, has been developed into a better and better product by the use of scientific methods with attention focused directly on the use requirements. Examples of similarly developed cottonseed products are high grade shortenings made with cottonseed oil with greatly improved keeping properties, and so-called high ratio shortenings which permit a high sugar-to-flour ratio for use by commercial bakeries.

With this brief description of the research method, let us consider now research on lint cotton, or what is usually referred to simply as "cotton." Beginning at the point at which cotton is received from the gin, scientific and technological research on lint cotton can be divided into three main classes: first, there is research which deals with the chemical and physical properties of the individual fibers; second, research which has to do with the mechanical processing of cotton and its manufacture into various products; and third, research in the field of chemical finishes for cotton products.

It is obvious that the properties of yarns and fabrics depend ultimately upon the physical and chemical properties of the individual fibers. Despite this fact, most of the cotton products produced today make use of cotton's inherent fiber properties in only an empirical manner; that is, by trial and error man has found that cotton of certain varieties grown in certain localities is suitable for, say, tire cord, while other varieties grown in other localities are not. Moreover, there are comparatively few uses for which even an empirical relationship of this nature has been established. Such a condition as this has existed partly because use requirements, in general, have never been carefully and systematically studied, and partly because only a few of the relevant fiber properties have been known or measurable.

Just as yarn and fabric properties are ultimately dependent upon fiber properties, so are fiber properties dependent upon their own physical structure and chemical composition. Cotton fiber, as used in textiles, is the dead and collapsed residue of a once living tubular cell. When the seed hair dies and dries out at the time the cotton boll opens, it collapses ordinarily into the form of a highly twisted ribbon. The outer surface of the fiber is covered with pectic substances and a very heterogenous wax. The canal, or lumen, of the fiber contains nitrogenous substances, sugars, minerals, etc. The wall of the fiber consists of cellulose, in the form of a spongy, netlike framework.

Various scientists, who have studied the structure of the cotton fiber, report that the cellulose wall is made up of many layers of fibrils alternately spiraling in opposite directions, but roughly parallel to the fiber axis. Examination of the fiber under polarized light, and X-ray diffraction data have led to the belief that the cellulose of cotton fibers exists in two forms, one amorphous, and the other crystalline. The strength of cotton has been found to be closely related to the degree of its crystalline alignment. The best aligned fiber may be half again as strong as the most poorly aligned fiber.

While the comparatively high proportion of amorphous cellulose in cotton is undesirable from the standpoint of tensile strength, it is an advantage from other standpoints. For example, the fact that cotton is one of the least brittle of all vegetable fibers may be largely ascribed to the comparatively high proportion of amorphous cellulose. This lack of brittleness makes it possible for cotton to withstand continued flexing to a far greater extent than many other vegetable fibers.

Other fiber properties, such as rigidity, the ability to absorb moisture, and to resist deterioration from heat and sunlight, are all related to the physical and chemical structure of the cotton fiber.

Cotton fibers, like many biological materials, vary enormously among themselves in their properties. In length, fineness, wall thickness, strength, area of cross section, degree of spiral - every measurable property - all display large and seemingly unrestrained variation. This is particularly true, of course, among cottons of different varieties and from different localities. These variations in the properties of cotton fiber are very fortunate in that they contribute to the versatility of possible adaptations. On the other hand, they are detrimental where they cannot be brought under control and efficiently utilized.

Intensive and more comprehensive research is needed to explore the various physical and chemical properties of cotton fiber, to disclose their interrelationships, and to devise better means of measuring many of them, so that all of these properties may be utilized in the best possible way. Sufficient research has already been done along this line to demonstrate its real value in connection with the development of new and improved cotton products. This is true not only from the standpoint of mechanical processing, but also from the standpoint of developing new and improved chemical treatments to alter or enhance the properties of cotton products.

The second of three fields of research is that of mechanical processing; that is, the mechanical manipulation of fibers to form yarns, fabrics, and other cotton products. Research in this field is directed toward developing new cotton products, improved cotton products, and toward reducing the cost of cotton products. Successful research along these lines will obviously increase the use and value of cotton. Two methods of attack are open for accomplishing these ends: (1) the development of new and improved processing machinery; (2) the development of new and improved cotton products to be manufactured on existing processing machinery.

Considerable research has been conducted on processing machinery within recent years to reduce the cost of processing and improve the quality of cotton products, but in practically all cases these efforts have been directed toward individual processing units, without attention being given in a comprehensive manner to the continuity of cotton processing as a whole. Hence, with almost no exceptions, the basic principles and mechanical manipulations involved in spinning, weaving, and other cotton-textile processes, remain the same as they were when first devised many years ago.

Since the basic principles involved in the manufacture of cotton into yarns and fabrics have remain unchanged for so long, it is not easy to visualize what types of change might be effected to materially lower manufacturing costs. But to say that this cannot be done would be a dangerous statement. Even the modifications which have been effected during the past 15 or 20 years, such as the development of one-process picking, longdraft systems, and high speed spooling and warping,

have resulted in an appreciable reduction in costs, amounting in some instances to from two to three cents per pound on certain types of fabrics.

A broad approach to the entire problem of converting cotton fibers into yarns and fabrics is urgently needed, as well as critical studies and more intensive research on existing machinery and processes.

Problems associated with the development of new cotton products and improved cotton products on our present mechanical processing machinery is not new. The cotton-textile industry, from its beginning, has developed many hundreds of products. But very few of these have been developed by the use of scientific methods to determine the requirements for specific uses. This was only natural in an industry which, during its growth period, found markets for almost any type of staple fabric which could be produced. But today (that is, considering the present war demand for textiles as a transitory situation) the industry is facing an entirely different problem. Competition from other fibers and products is keen, and any further expansion of markets, or even the holding of some of the present markets, can be accomplished only by intensive research aimed at developing improved cotton products designed for specific uses.

The third major field of research deals with chemical finishes for cotton fibers, yarns, and fabrics. Within recent years, more research has been done on chemical finishes than in any of the other fields. This does not mean, however, that more research of this nature is not needed or that the opportunities for increasing the utilization of cotton in this manner have been lessened by the results already obtained. Instead of lessening these opportunities, recent progress made in the development of new and improved chemical finishes has actually indicated new opportunities which ten years ago were only in the realm of speculation.

In clothing and household fabrics, attractiveness to the eye and to the sense of touch are important competitive factors. The most important properties of cotton textiles which are distinguished by the sense of sight are color, luster, and drape. The principal properties which are distinguished by the sense of touch are flexibility, compressibility, resilience, density, surface friction, and thermal character. Some of the properties which affect the serviceability or performance of cotton textiles are the ability to absorb and transmit moisture, the resistance of the color in the fabric to destructive agents such as washing and sunlight, and the resistance of the fabric to shrinkage, fire, mildew, abrasion, and various chemicals. Chemical finishes can alter nearly every one of these properties of a cotton fabric.

Most chemical finishes fall into two classes. In one of these the means employed consists of actual physical or chemical modification

of the cotton fiber, as is illustrated by the process of mercerization. In the second class are the additive treatments, of which the application of a water repellent finish to a piece of cotton fabric is an example. Many possibilities exist in both fields.

The needs with regard to chemical finishing include more effective finishes, and more permanent and less expensive finishes than many of those now available. Also, new kinds of finishes are needed to produce new effects in cotton textiles to adapt them to uses now served by other fibers. In particular, special attention must be given to those finishes which will strengthen the competitive position of cotton with respect to rayon, nylon, and other synthetic fibers. Fortunately, cotton is considerably cheaper than any of those newer textile fibers and this provides a price margin for the application of chemical finishes to cotton fabrics.

Briefly, these are the three major fields in which research is needed to find new and expanded uses for lint cotton. Cottonseed, as you know, is the other principal commercial product of the cotton plant. With the advent of the cottonseed crushing industry, on an appreciable scale, in the 1880's, the number and value of the byproducts from cottonseed increased steadily. Today, we obtain from cottonseed such commercial byproducts as linters, oil, cake and meal, hulls, hull fiber, and hull bran. Owing to the demand created by the war, the first three of these products enjoy a ready market at present. Uses are being developed for the last three products but the demand is far below the potential production.

Although linters are now in tremendous demand for the production of chemical cotton for the manufacture of smokeless powder and other cellulosic war products, it is to be expected that when the war is over a surplus will soon develop. Moreover, the oil and meal are still used primarily as food and feed, respectively, and their industrial use aside from these fields is negligible.

It has been evident for a long time that additional industrial outlets are needed for cottonseed products. New uses and new processes employing these products necessarily must be found and developed through research.

People familiar with the properties and composition of cottonseed oil believe that the chemical and physical properties of cottonseed oil can be altered to make it adaptable to many industrial uses, as for example the textile industry, and the tin and terne plate industry. In the processing of cottonseed, the adaptation of solvent extraction will not only make possible more economical recovery of the oil but will also permit the industrial use of the meal which is not possible today because of the alteration and damage to the protein which occurs in the hydraulic and expeller processes. It has been demonstrated that meal produced by these expression methods of removing the oil

can be used to a limited extent in the production of certain types of adhesives and plastics; but for other types of adhesives, i. e., paper sizes and coatings, and for synthetic woollike fibers, solvent extracted meal is required.

Not only the future expansion of the cottonseed industry, but its future existence under the highly competitive marketing conditions which are more than likely to exist following the cessation of the present hostilities, will depend on the extent and success of present and future research in this field.

I have tried to outline the major fields and nature of technological and scientific research which must be intensely prosecuted on cotton and cottonseed products, if the cotton industry is to hold its position in the future as a major industry. In New Orleans, Louisiana, the Southern Regional Research Laboratory of the Bureau of Agricultural Chemistry and Engineering, United States Department of Agriculture, is conducting research in each of these fields. This is not just a coincidence, for the research program of the Southern Regional Research Laboratory was selected after a painstaking and extensive survey of the entire cotton industry.

There are also many private and semi-public organizations conducting and sponsoring research in one or more of these major research fields, and within recent years many new and improved cotton products have been developed. Their aggregate effect on total cotton consumption has not, as yet, been appreciable, but these developments are encouraging, because they represent progress in all of the major fields of research. Perhaps you would be interested in a brief description of a few of these recent developments.

Just before the war started an inexpensive cement shingle, using cotton fabric as a reinforcing membrane, was invented and used in the construction of several houses. If satisfactory service is obtained from these roofs, this product is expected to develop into quite a large use for cotton. Another development, temporarily arrested by war conditions, is a new method of making cotton pile fabrics for use in covering automobile seats, furniture, etc. By this method, cotton cut to a few thousandths of an inch is electrically deposited on fabrics which have been coated with an exceedingly strong adhesive. As many as 300,000 fibers per square inch can be deposited by this method. By applying adhesive to an open weave fabric in various patterns, attractive window curtains can be made in this manner. Still another new development is a fabric made without spinning or weaving. By one process, several layers of cotton web are produced on a carding machine and impregnated with synthetic resins to form felts for industrial use. By another process, the layers of web have an adhesive grid impressed upon them to form disposable towels for use by dentists, physicians, and others. Large quantities of these latter fabrics are now being produced for military use.

Newly developed flame-proofing and water-proofing treatments are being extensively used to increase the serviceability and value of cotton products. Wrinkle-resistant finishes are also increasing the usefulness of cotton fabrics for clothing and household purposes.

Shortage of various imported fibers has brought about the development of several new cotton products; among these is a special cotton yarn now being used to make webbing for parachute harness which was formerly made from linen.

The research work on cotton at the Southern Laboratory and, in fact, all of the work of the Bureau of Agricultural Chemistry and Engineering of which this laboratory is a part, is now specifically directed toward aiding the Allied Nations in the war effort. Most of the projects which would require years to yield useful results have been deferred until the end of the war. Short-time special projects of a war effort nature are given precedence over all others.

One accomplishment of this special war work is the development of means for cutting cotton to uniformly short lengths so it can be used with existing commercial equipment to supplement linters for making smokeless powder. On the basis of extensive experiments, the War Department was furnished with a list of effective treatments for protecting sandbag fabrics from attack by soil micro-organisms. This work is continuing and includes the development of new and more effective treatments. Some of the other war work includes plastic-coated or impregnated fabrics for replacing rubberized fabrics; an unlined cotton fire hose to replace linen hose of the same type; improved mesh fabric for use as a base for non-shatterable transparent plastic substitutes for window glass; the development of cotton products to replace those made from certain imported fibers which are difficult or impossible to obtain; and some other projects which cannot be discussed on account of their war nature.

Similar intensified efforts are being directed toward the development of products from cottonseed to replace materials either entirely cut off by the war in the Far East or which are short owing to excessive demand resulting from the war and assistance to the United Nations under Lend-Lease arrangements. Projects of this type include work on the development of adhesives from cottonseed meal for use in the manufacture of plywood; of paper coating material to supplement casein protein; and synthetic woollike fibers for industrial and civilian use. This group of projects includes the development of modified cottonseed oil to replace olive oil in the textile industry, palm oil in the tin and terne plate industry, and certain waxes imported from the Far East.

In opening, I mentioned that the technological and scientific research to find new and extended uses for cotton was being conducted more or less independently by the different cotton-producing and cotton-consuming countries. Until recently this was also true of the various

organizations conducting research within the United States. Obviously such independent action often means duplication of effort which can largely be avoided by some form of coordination.

The free exchange of current information in regard to objectives and results obtained is highly desirable. Today most of the public and semi-public cotton research organizations in the United States are following this practice, and the private organizations are cooperating as far as possible, consistent with their own interests in relation to their competitors. The value of such coordination and correlation of research effort has already been demonstrated in many instances.

About the time the world war started, the Southern Regional Research Laboratory was beginning to establish contacts with public research organizations in other cotton-producing and cotton-consuming countries for the purpose of arranging for the exchange of information dealing with research on the utilization of cotton. Like a number of other desirable activities, this one was interrupted by the spread of this world conflagration to the Western Hemisphere. When the war is over these contacts will be renewed and strengthened, and others made. With our mutual interests in the future of the cotton industry of the world, we can look forward to a closer coordination and a more effective use of our efforts to find new and extended uses for cotton.