OREGON AGRICULTURE 2

FIBER-FLAX

An Appraisal of the Problems and Possibilities

An analysis by a committee of
the Agricultural Staff of
Oregon State College.

D. D. Hill F. E. Price
D. B. DeLoach

JUNE 1946

Oregon Agricultural Experiment Station Collaborating with the Bureau of Plant Industry, Soils, and Agricultural Engineering, of the United States Department of Agriculture, and the Oregon Federal Cooperative Extension Service.

OREGON STATE COLLEGE
CORVALLIS

FOREWORD

In 1944 a committee of the faculty of the School of Agriculture was appointed to make a study of agriculture with a view to recommending policies for the guidance of the School of Agriculture in its three major divisions, resident teaching, research, and extension. The committee membership included personnel from these three major divisions. To assist in this work, the committee in turn appointed thirty sub-committees, each to consider a specific area within the field of agriculture. Membership of these sub-committees likewise consisted of resident teaching, research, and extension staff members, and the membership also was developed to include specialists not only in the specific area of activity under consideration but also allied areas. For instance, committees having to do with the many phases of livestock consideration included farm crops specialists in addition to animal husbandry specialists.

These committees applied themselves intensively, and the results were thirty reports unanimously acceptable to committee members. These thirty sub-committee reports were briefed, summarized, and drawn together in a single background statement. This statement represents the opinion of the faculty of the School of Agriculture as a basic cross-section of the State's agriculture, and is published as number one in the current series on Oregon agriculture. In addition to the conclusions presented, the committees made many suggestions valuable to the administrative staff in regard to reorganization, shifting of emphasis, and instructional procedure.

A representative number of sub-committee reports will be published in greater entirety than is possible in the background statement to serve as individual contributions to the commodity interest areas involved. This publication is the second of the series covering phases of Oregon Agriculture.

Wm. A. Schoenfeld

Dean and Director

Fiber-Flax in Oregon
An Appraisal of the Problems and Possibilities

By

D. D. Hill, Agronomist
F. E. Price, Agricultural Engineer

and

D. B. De Loach, Agricultural Economist

INTRODUCTION

Fiber-flax must be processed before it can be offered for sale; therefore, ample processing facilities must exist before flax growing can be undertaken. Many commodities are processed before sale to the consumer, but these generally are sold direct to a processor. Fiber-flax, however, must be processed before line fiber and tow can be sold to the manufacturer. Payment to the grower depends on the quality and yield of fiber from a crop in relation to price which is not determined in a cooperative organization until a year or two after the crop has been produced and delivered to the processing plant. In considering the production of fiber-flax, the processing facilities are necessarily an important phase. It is not sufficient to determine that good yields of good quality flax straw can be economically produced. It is also necessary to provide and to maintain efficient processing facilities to extract the line fiber and tow, the main flax products, in order to compete effectively for available markets. This competitive struggle for efficiency in growing, harvesting, processing, and marketing is the main point for the consideration in this report.

INDUSTRY, DEVELOPMENT, AND PRESENT COMPOSITION

Historical

The early settlers in the Willamette Valley demonstrated that fiber-flax could be grown here successfully. The first record of fiber-flax production in the Willamette Valley is that of Mrs. J. B. Kirkwood in 1844. Later records show that in 1876 a twine plant was operated at Albany for the purpose of making twine out of fiber-flax. Approximately 5,000 pounds of twine were manufactured monthly in this plant which was later destroyed by fire.

The fiber-flax industry was given an impetus in the Willamette Valley in 1915 when the Legislature appropriated $50,000 for the construction of a flax processing plant to be operated in connection with the State Penitentiary. From 1915 until 1936 this plant offered the only processing facilities for growers of fiber-flax in the Willamette Valley. The plant suffered several disastrous fires but eventually was rebuilt and enlarged to handle additional acreage. The State Flax Plant now handles flax from an acreage of approximately 3,500 acres each year. This acreage has fluctuated from less than 1,000 acres to as much as 4,000 acres.

Organization of the Industry

The flax acreage in Oregon began to expand after 1936 when three new plants were started at Canby, Mt. Angel, and Springfield. After these plants were constructed by the State and the Works Progress Administration, they were leased to growers cooperatives in these districts. Additional plants were constructed following the outbreak of the European war in order to supply flax fiber which was formerly imported in considerable quantities. In all, 7 cooperative and 3 private plants were built. Capital for construction of the 10 new plants was obtained from private sources, from the Bank for Cooperatives, from The Commodity Credit Corporation, and from the Defense Plant Corporation. The fixed investment for all 13 processing plants is estimated to be in excess of $1,250,000. One of the private plants suspended operations in 1944. This leaves 12 plants and the state plant at the penitentiary in operation. The facilities provided by the existing processing plants will require flax from 15,000 to 20,000 acres annually to keep the plants working at maximum capacity. In this event each plant will require a permanent personnel of about 30 and a seasonal labor supply of 30 or more additional workers.

RESEARCH ACCOMPLISHMENTS

The Oregon Agricultural Experiment Station gave some attention to fiber-flax nearly 50 years ago as is indicated by a publication issued in 1897. The United States Department of Agriculture in cooperation with the Experiment Station began work on the agronomic phase of the crop in 1932. During the period 1934 to 1936 a study was made by these agencies dealing with the cost and efficiency of fiber-flax production in the state. In 1938 work of an engineering nature was started by the Department in cooperation with the Experiment Station. A study was made in 1942 by the Oregon State College of the local flax industry with particular reference to marketing.

Agronomic

The breeding and other agronomic work with fiber-flax that started in Oregon on a full-time basis in 1932 was formerly in Michigan where new varieties were developed. Much of the basic research data were obtained and the information published. Nearly all of the American and European fiber varieties have been tested and several new ones have been developed since the project has been located here.

A variety from Ireland, Stormont Cirrus, which was shown by experiments to be superior, was recommended; and in 1933 a bushel of seed was supplied to the State Flax Industry. This was increased by them until most of the flax being planted previous to 1940 was of this variety.

The Martin variety, developed and increased prior to 1942, is being grown by four of the Oregon processing plants. The Cascade variety also developed at the Oregon Station has recently been released for seed increase but is not yet in sufficient quantity for fiber production. The latter variety shows a great deal of promise on account of its resistance to disease and high yields. Since flax rust is becoming a serious problem in this area, the necessity of a resistant variety is obvious. Many new strains have been developed that show promise but have not been tested adequately.

Most of the common agronomic practices have been tested and recommendations based on the results have been made in publications.

Extensive tests have been made with fertilizers for flax. The Extension Service has based its recommendations on these findings.

Studies of retting have been made to determine the procedure for optimum fiber yields and quality of fiber.

Almost complete control of many of the annual and some perennial weeds found growing with fiber-flax has been demonstrated to be possible by selective sprays. The yield and quality of the crop may be materially increased by spraying and foreign material and dockage are both reduced in the harvested product. Reduction of crop returns by annual weeds constitutes one of the major losses to fiber-flax. Eradicating weeds without injury to the crop is of great economic advantage to both grower and processor.

Engineering

The work of an engineering nature on fiber-flax was started at an opportune time for results to be of assistance to the industry during the period of rapid expansion brought about by World War

II. Some equipment of modern design developed in Europe had been imported, tested under Oregon conditions, and was in production; several pieces of new equipment developed at Corvallis had been introduced and thoroughly tested; building plans prepared to facilitate more efficient processing operations were available; and a study of fire control in Oregon mills has been made.

Since the project was started, experimental machines for harvesting and for performing practically all processing operations have been constructed and tried out. A great majority of these devices were immediately junked and the parts used for some other machine, but several have been of value to the industry. The machines which have been adopted by the industry or show some promise include a puller with pneumatic gripping device which does not injure the straw; a deseeder which reduces labor requirements in this operation; a fiber-flax combine which pulls and deseeds flax in one operation; retted straw binding and loading equipment for reducing labor; a scutcher designed to increase the yield of line fiber per unit of retted straw; a tow shaker for removing loose shives and trash from scutching tow; a tow cleaner for producing spinning tow; an elevator for loading wagons at the deseeder which eliminates one man from each deseeding crew; and built-in elevators in storage sheds for reducing labor requirements.

The puller with pneumatic gripping device, the fiber-flax combine, retted straw binding and loading equipment, and the scutcher mentioned have not been produced commercially. The deseeder is in use at about half the Oregon mills, the tow shaker is standard equipment at all flax mills in the state, two tow cleaners of the type in question are in use and one has been ordered from a local machine shop, elevators for loading wagons at the deseeders are used in practically all mills, and three plants have built-in elevators for filling storage sheds.

The deseeder development is estimated to be worth about $10,000 per year to the industry at present price levels for labor. One mill has marketed about $70,000 worth of tow from an experimental tow cleaner at a time when there is practically no market for uncleaned tow. Five of the new flax mills used plans developed at Corvallis and several old mills used them in connection with expansion and remodeling. In all, new mills and additions valued at possibly $500,000 are based on these plans. The availability of the plans helped materially in getting construction work underway quickly and in standardizing design along desirable lines.

The results of a study of fire hazards at flax mills was beneficial to the industry in that flax mill managers were made more fire-conscious, and all parties interested in fire control were brought closer together. The State Fire Marshall's Office, the Insurance Rating Bureau and Insurance Company representatives became better acquainted with the industry, and flax mill managers came to realize that fire hazards must be reduced and fire protection facilities increased to bring about lower insurance rates.

Economic

A careful study of the cost of producing fiber-flax in the Willamette Valley of Oregon was made by interviewing a large number of flax growers to obtain from them data regarding costs incurred and practices used in growing fiber-flax. This study was carried on over a three year period, 1934 to 1936 inclusive, and during this period a total of 239 flax-enterprise records were obtained. The major objective of this study was accomplished in determining the costs of growing fiber-flax in the Willamette Valley and the significance of these costs to the economic status of the industry. The information was published in 1938 under the title *Cost and Efficiency in Fiber Flax Production in the Willamette Valley, Oregon.*

In 1941-42 a study was made to determine the economic outlook of the fiber-flax industry based upon a study of industry background, markets, competition, and government policy relating to the fiber-flax industry. Much of the information shown in the marketing section of this bulletin was obtained in this study.

Economic Considerations Limit Acreage

From an economic standpoint the potential flax acreage of the Willamette Valley is limited largely by the processing facilities and by the relative prices which the farmers will receive for the straw. From an agronomic standpoint it is estimated that one-half million acres of land in the Willamette Valley should produce fiber-flax satisfactorily. It is expected that 50,000 acres of fiber-flax could be grown in the proper crop rotation should this be necessary.

The attitude of the growers has been an important consideration in the extension of fiber-flax acreages. Up until relatively recent years this crop has not been a popular one with farmers largely because of the large amount of hand labor involved in harvesting. With the development of harvesting machinery and mechanical scutchers some of the original objection to growing flax disappeared. Farmers generally have found that flax is no harder on the land than other crops. They are willing, therefore, to produce flax if it provides them a financial return commensurate with that received from competitive crops. The diversity of other crops that may be grown in the Willamette Valley makes this an important factor.

The attitude of growers is often influenced by the price and by the time required for them to receive full returns on the crop.

Processing is always extended over a one-year period and sometimes longer. Final payment to the grower can not be made by a co-operative plant until after his flax is processed and the fiber from it is sold. Many of the new mills are attempting to pay for their processing plants and facilities as quickly as possible at the expense of the growers. Other plants, especially the older ones, are generally in good shape financially. For these reasons the price paid for straw varies widely, which is disconcerting to growers.

Flax growing entails risks not common to most other crops. Should unfavorable weather conditions reduce the yield, the value per unit is reduced as well. Flax which yields 2 tons or more of straw per acre will be mostly of the No. 1 grade. Flax which yields in the neighborhood of 1 ton per acre or less is likely to be largely of the No. 2 or No. 3 grades. Such flax will generally have shorter straw and will often have more weeds. The end result is a lower yield of a lower quality of line fiber. The introduction of a flax puller in 1923 and mechanical scutchers about 1927 by the State Flax Industry was the first step in mechanizing the industry. These introductions were of great value as they provided the basis for an industry rather than jobs for prison inmates.

PRODUCTION EFFICIENCY

Although the ultimate establishment of fiber-flax production in Oregon on a permanent basis will depend largely upon market factors, there are nevertheless a number of important production problems. It is evident that the flax producer in Oregon will be faced with vigorous foreign competition. If he is to survive in this struggle, it will be necessary for him to make certain improvements in his producing methods.

Naturally one of the first objectives in any improvement in production will be directed toward the production of more flax per acre, in other words, higher yields. While it is true that flax is grown on the better fields on individual farms, it is also true that these fields can be improved. Greater yields can be obtained by better crop rotation practices which will provide a more fertile soil and fields that have fewer weeds. Undoubtedly, more fertilizer can be used profitably on many farms. It is entirely possible that irrigation may prove to be a profitable investment on flax land. The production of those varieties which will give increased yields is still another possibility. Production records in Oregon show that prior to 1944, only a relatively small percentage of the total acreage was growing the varieties that have proved to be best adapted. The change to improved varieties is proceeding as rapidly as seed stocks are available.

The production of more flax per acre will not in itself be sufficient. It will be necessary for the grower to produce better flax. It may be argued that the improvement in production practice which will permit increased yields will also produce better flax. This may be true in some instances, but it also may be untrue in others. Improvement in quality of flax may be brought about in a number of ways.

Selection of Varieties

Those varieties should be grown which will produce a superior quantity or quality of fiber or those varieties which will give the greatest uniformity in the harvested straw.

Cultural Practices

One of the principal factors in increasing cost of processing under present conditions is the lack of uniformity in the straw supplied to the plant. This lack of uniformity may be the result of low fertility, poor seedbed preparation, or lack of uniformity in the fields producing the straw. It is common complaint of processors that the straw delivered may vary from very small straw to rather coarse straw large in diameter. Straws which exhibit this range in size require different periods of processing. When all are contained in the same lot, it is impossible to process all of the straw in the most desirable way. Likewise, variation in height of straw in the same lot makes it extremely difficult to process the retted straw in the scutching machine. Finally, the weed content of the flax straw interferes with the retting and scutching operations. The establishment of uniform straw grades impartially applied would do much toward correcting this situation.

Harvesting and Handling

It is a common complaint of many processors that a certain percentage of the straw is crushed in the pulling operation. These crushed straws ret at a more rapid rate than the uninjured straw; consequently the processors are not able to recover as much fiber or as much good fiber. A puller has been developed which will harvest flax with little injury, but it is not yet in production. Greater care in shocking, loading, and hauling the straw to the mill is necessary.

PROCESSING FUNCTIONS

Receiving and Storage

Fiber-flax is delivered to the processing plant in bundles with the seed remaining on the straw. It is standard practice for the plant to deseed and ret as much of this as possible before the fall rains. This is considerably less than half of a capacity crop. Sometimes this straw is deseeded during the winter months in order to distribute labor requirements or to allow marketing the seed before spring. In any case storage sheds must be provided for the current year's crop, as well as for part of the straw that has not been processed from previous years.

Deseeding

The bundles are spread for deseeding so that as a layer of straw goes through a machine a revolving comb removes the seed bolls. This seed is separated from the chaff by a stationary thresher or a combine used as a stationary machine. The deseeded straw is tied with a double-needle binder which puts two strings on each bundle to make them easier to handle when wet.

Retting

Retting of a previous year's crop is started in the spring as early as the straw can be dried outside in the open air. This continues until delivery of the current year's crop enables the deseeding and retting of the straw as it comes in to the processing plant from the farm. The straw is retted by placing it in open concrete tanks, most of them 16 x 40 x 7 feet, and covering with water. It is kept warm and allowed to ret or "rot" for several days. When retting is completed the straw is hauled to the drying field and the bundles are set up in a form of Indian wigwams. The dried straw is again tied in bundles and put back in the storage shed.

Scutching

Scutching, the separation of the fiber from the woody portions of the stem, may continue throughout the year if supplies of retted straw are sufficient. Scutching is usually confined to the fall and winter months when the higher moisture content of straw causes the fiber to be less brittle. During the present emergency, many plants are operating throughout the season. In this operation the long or "line" fiber comes out clean and parallel. The short "tow" fiber that is beaten out or broken off in scutching is separated from the shives by shakers, breakers, etc. Not entirely free of woody material and tangled, the tow fiber commands a much lower price.

Hackling

The scutched line fiber is sorted and combed by pulling the fiber over pins in a board. This process is usually called "hackling," but should not be confused with machine hackling which is done by the spinner.

PROCESSING CAPACITY

Oregon flax mills have the facilities for processing 35,000 to 40,000 tons of pulled flax annually. Maximum capacity has not been reached at a few of the new mills partly because of delays in completing the plant, shortage of labor, and lack of straw.

There does not appear to be any interest either by existing processors, government agencies, or new private capital in further expansion in the capacity of processing facilities at this time. If the need should arise, it may be done by increasing both facilities and plants.

Present Facilities

Some of the processing plants could increase their capacity by the addition of certain facilities. This would be practical for economy in management but is limited in some areas by available acreage. Also, some plants have facilities that are about balanced and any increase in capacity would require an expansion of all facilities.

The Number of Plants

There are a few areas in Oregon that could support a processing plant without serious competition to the established plants. While other states have grown fiber-flax from time to time this is the only area in the United States, except Michigan, where fiber-flax is grown and processed commercially now. The production of spinning fiber in the state of Michigan is almost nil. The small amount of flax produced in the state of Washington is processed in Oregon. The state of Washington offers the possibility of expansion especially in Clarke County and adjacent areas where soil and climate are favorable to this crop. Expansion into western Washington might further stimulate the interest of spinners who might look to the northwestern United States for a location if such an expansion materially increased the supply of fiber in this region.

PROBLEMS INVOLVED IN PROCESSING

CAPITAL INVESTMENT

The capital investment in processing plant for fiber-flax is high per acre or unit of production. A processing plant with an annual capacity of 200 to 250 tons of line fiber will cost from $150,000 to $200,000 to build and equip at the 1944 level of prices. In order to operate at capacity, a large part of about 2,500 tons of straw must be kept in storage for several months and often some of it is held for two or more years before it can be marketed as fiber. Sufficient working capital must be available to the processor to cover purchase of the straw from growers or to make a partial payment to patrons in cooperative associations. Either the processing plant or the grower has an average working capital of approximately $60 per ton tied up in the pulled straw. In addition to the purchase price or advance on straw, the cost of storing, deseeding, retting, and scutching must be paid before the returns from this fiber are received. The experience of recently established plants indicates that more than $100,000 in money or credit must be available to meet current operating needs. Generally speaking, the farmer invests in both growing and processing. This is especially true at the cooperative plants where about 75 per cent of the flax is handled.

LABOR REQUIREMENTS

Labor accounts for the major portion of the cost of processing although many of the operations are performed by the use of machines. Efficiency in many of the operations requires training and skill, even though some of the labor requirements for processing flax are of a seasonal nature. During the summertime separate crews are needed for deseeding, retting, drying, receiving in the storage sheds, and sometimes for scutching. During the winter months only one or two scutching crews are needed, except for an occasional deseeding crew. The peak of the summertime requirements may range from 40 to 80 employees, and during the winter the requirements usually are reduced by 50 per cent or more.

SORTING STRAW FOR QUALITY

Segregation of the straw and storage according to quality (length, diameter, weeds, maturity, etc.) is one of the first and major processing problems. The different kinds and qualities of straw require different amounts of time for retting and different speeds for scutching. Usually the straw is not classified before delivery and little effort is made to segregate it for quality. All of the crop is delivered during a few weeks, and the resulting congestion makes accurate segregation difficult.

If all of the straw were classified before delivery according to quality of processing, the tonnage estimated, and storage space assigned, some effective segregation might be obtained. Separate storage of flax from which planting seed will be obtained should be possible at the same time. The latter is important in maintaining pure seed stocks.

DESEEDING

When the bundles delivered to the deseeder are ragged and uneven at the butts, the process is slowed down. Some seed is left on the straw, some of the straw is usually pulled out and lost, and it is difficult to obtain an even bundle of the deseeded material. If the straw is not eventually even at the butt ends, excessive loss in ensuing operations will result.

The most probable future improvement in the deseeding operation appears to be a more general use of the improved multiple comb deseeder. There is more need for improvement in careful evening of the straw after deseeding. A great help along this line has been an automatic butter which evens the straw as it passes from the deseeder to the binder. Only two of these are in operation; but the industry is showing a great deal of interest in them; and it is probable that more will be installed.

If pure seed for planting is to be maintained, it is essential that it is not mixed in deseeding. Nearly all of the processing plants handle more than one variety of seed, and in most cases it appears to have been mixed.

RETTING

The outstanding characteristic of the retting procedure in Oregon is the extreme variability between the different methods followed at the different processing plants. The retting is all done in open tanks and the water is heated by a boiler fired with shives or other flax wastes when they are available; otherwise wood or sawdust is used as a supplement.

The variations in the retting procedure are too numerous to mention. It is desirable to add some fresh, warm water during the period of the ret, but not excessive amounts. The addition of fresh water equal to the total volume of the tank is a generally acceptable procedure.

The most important, and also the most difficult, phase of the retting is to determine the end point accurately. To be able to do this with different types of straw requires a considerable amount of experience. Much research work has been done on this phase of the work, but as yet nothing dependable that does not depend almost entirely on the judgment of the retter has been devised. After the ret is completed, the straw is washed with cold water which stops the ret and washes out most of the retting liquor.

Further information on retting is needed, among other things, on the following:

1. The amount of leaching before the ret proper is started and the effect of such leaching.
2. The effect of time and temperature of retting.
3. The effect of inoculating with retting water from another tank or by pure cultures.

4. The amount of washing and the temperature of the washing water.

5. The effect of physical qualities of the stem on the time required for retting.

6. The effect of maturity of the straw on the time required for retting.

7. The difference in results with covered and open tanks and the fundamentals involved in such difference.

DRYING

Natural drying results in an acceptable quality of fiber, but it handicaps the industry through high cost of labor and facilities. If an artificial dryer can be developed which will maintain fiber quality, it will facilitate the streamlining of plant operations and increase labor efficiency. Early spring and late fall retting are very hazardous because adverse weather conditions may make it impossible to dry the straw before it is ruined or badly damaged by continuing to ret in the drying field. Labor requirements for drying represent about 40 per cent of the cost of retting and drying. This might be somewhat reduced by artificial drying; but flax by-products will not provide sufficient heat for removing water from the straw, and an additional cost must be included for fuel. Some spinners insist that the quality of the fiber from artificially dried straw is considerably inferior to naturally dried flax. The chief advantages of artificial drying are the continuous nature of the operation where a large portion of the seasonal type of labor may be eliminated, and the delay between harvesting and marketing is reduced. Furthermore, there is little dependence on the weather and with proper management the straw from each year's crop may be processed before another is delivered to the mill. The problem of artificial drying needs a considerable amount of research especially regarding the quality of the fiber produced before definite conclusions can be drawn.

SCUTCHING

If the straw is properly retted, the greatest needs for improvements in scutching are: (1) a machine that will increase the yield of line fiber with a corresponding decrease in tow; and (2) a uniform straw with even root ends.

Usually some adjustment of the scutcher speed is necessary when the straw from another ret is started. If economically feasible, better yields would be obtained and less time would be required for the adjustment of the machine if the straw from each tank was scutched as a unit. If the straw is sorted before retting and the retted straw from the individual tanks kept together, much less frequent adjustment is necessary. The speed of the scutching machine is critical and a slight increase or decrease materially changes the line-tow ratio. More general use of speed control devices by which the speed of the machine may be gradually changed while in operation is desirable.

As the straw is spread for scutching, the workers are expected to arrange it so that the root ends are even. This precaution is often neglected and results in losses in line fiber. Straw of uniform length and diameter facilitates scutching.

HACKLING

Hackling requires a considerable amount of skill to dress the fiber properly without excessive loss of line fiber. During the war period there has been a good market for all grades of fiber which accounts for the tendency to do a minimum amount of hand hackling on the fiber sold to spinners. The effort of processors to economize in the use of labor results in a greater loss by the spinner when the fiber is machine hackled. Research is needed to determine the amount of hand hackling that will result in the least tow from the hand hackling and the machine hackling combined.

TOW CLEANING

Tow must be processed through special equipment before it can be sold to tow spinners. The type of equipment necessary for this processing depends in part on the use to which the tow is put. Two general types of tow processing equipment are now in use. One of these is operated by the state flax plant. The principal drawbacks to this type of equipment are the large original cost, the relatively heavy cleanout, and the large number of people required to operate it. However, the machine does produce an excellent quality tow that brings a high price.

A different type of tow cleaning equipment developed at Corvallis is in use at two cooperative plants and is being installed in a third. This equipment is relatively inexpensive and produces a tow that is satisfactory for certain purposes. One cooperative that has two seasons' operation with such a machine has sold the tow at a good price.

Additional tow cleaning equipment is needed. It has been proposed that a central plant, equipped similarly to the state plant, could handle tow from a number of the private and cooperative plants. The heavy initial investment in this type of plant makes it imperative that a large volume of tow be assured if such a plant is to operate profitably. In view of this difficulty, there is a tendency for individual plants to consider the relatively inexpensive equipment that is adapted to individual plant operation. Certainly, processing and sale of all tow are essential to profitable plant operation.

BY-PRODUCT UTILIZATION

Economic utilization of the principal by-products from flax milling is essential as returns from the line fiber alone are insufficient to support the enterprise under normal price conditions. A market for flax by-products at reasonable prices would tend toward more efficient operation of plant, thereby reducing the unit overhead assignable to line fiber. With present equipment and procedure, the by-products are seed, scutching tow, green tow, shives, and retting water. There is a ready market for the seed; the tow market is unstable; shives are used for fuel at the mills; and the retting waste is disposed of as sewage.

Seed

When it is not used for planting, seed is sold to oil mills usually at the same price as seed from the regular seed-flax varieties produced for oil. A market therefore is established for the seed through regular trade channels.

Scutching tow

The mass of tangled fiber produced in the scutching operation is known as scutching tow and is used for spinning thread from which are manufactured toweling and other coarse fabrics. Some scutching tow also finds its way into the paper trade. Tow, therefore, must compete with a variety of low cost products. For spinning it must compete with cotton, jute, hemp tow, and seed-flax tow. Except for paper used in currency and flour sacks where a flax fiber can be used in the paper to add strength, fiber-flax tow must compete with wood waste, seed-flax tow, and a variety of other such waste materials. Flax fiber is used for cigarette paper, but the industry at present relies upon seed-flax tow because of its availability in large quantities at low cost.

Green tow

Produced from tangled unretted straw or straw which is too short for producing line fiber economically with existing facilities, small quantities of green tow are sold occasionally to the furniture trade for upholstery. Returns are considered insufficient to justify the expenses involved in cleaning the straw, however, especially in view of the limited market. Such tow could probably be disposed of to the cigarette paper industry. However, the volume is insufficient to attract their attention, especially if changes should be necessary in their manufacturing procedure in order to process the fiber-flax tow.

Shives

The woody portion of retted straw which accumulates from the scutching operation is called shives and provides sufficient fuel at flax mills for heating the water for retting. It has a high heating value but is bulky and somewhat expensive to store and fire. While shives might have some desirable properties for use in plastics, it is doubtful whether it can compete with wood waste materials in Oregon for industrial purposes.

Retting water

In view of efforts being made to prevent stream pollution in the state which are tending to eliminate the use of streams for dumping, retting water is a problem. The retting waste is low in oxygen and contains considerable organic material. For this reason the oxygen content of water in streams receiving retting waste is reduced and may become insufficient for supporting higher forms of stream life. Retting water has some fertilizer value and has possibilities for use in irrigation. Care is necessary, however, in applying the water to prevent injury to crops.

QUALITY OF FLAX

The question of straw and fiber quality is intimately associated both with the production of the straw and with the processing of it. Likewise in any consideration of the marketing problem for flax, fiber quality is paramount. Attention has been called to the variation in flax as it comes from the field and to the variation in quality as a result of processing. Improvements in production and in processing, therefore, are essential to establishing a stable outlet for Oregon fiber. It is pertinent, then, to ascertain what use is now being made of this fiber.

Most of the line fiber produced in Oregon is now used in the production of various kinds of thread and twine. During war conditions very little of the fiber is ultimately used for weaving purposes. Despite the present limitation in usage, much of the fiber produced is suitable for weaving of the coarser linen fabrics. There are indications that the better grade of fiber is suitable for a good grade of linen fabric, in fact, for most grades manufactured except the very fine linens. Prior to World War II little flax produced in

Oregon was used for weaving purposes, a condition that might be attributed to the manufacturers' unwillingness to deal with such small quantities.

There is lacking a definite expression from the manufacturers of the suitability of Oregon fiber to their needs. Statements that have been made about the desirable qualities of Oregon fiber do not necessarily represent a market demand. The industry needs definite assurances from the manufacturers that the quality is suitable and that Oregon fiber is desired.

The variations in processing and production, to which reference has been made, can have a pronounced effect on the quality of the fiber. More information is needed about the specific qualities needed by manufacturers so that improvements in production and processing can be directed toward the production of the desired quality of fiber. Obtaining this information should be a primary consideration in the fiber grade study.

Any improvement in straw quality must come through a better grading system and improved production methods. A uniform grading system based on a set of definite and comprehensive grades would do much toward stimulating the necessary improvement in production methods. If better straw were brought to the processing plants, and if this straw were of improved variety, then the processor would have a much better opportunity to improve the quality and amount of the fiber produced. The installation or utilization of tow processing equipment which will produce a quality of tow that is usable by tow spinners is necessary in all but a few plants.

It is believed that a marked improvement in the quality of fiber is physically possible, but it is not economically feasible with present price and labor conditions. This improvement, however, is absolutely essential if Oregon flax is to meet successfully the postwar competition of European flax.

THE MARKET FOR OREGON FIBER-FLAX

Oregon Fiber-Flax Marketed Mainly in the United States

The market for Oregon-grown fiber-flax, and the products derived therefrom, has been limited almost entirely to the United States. A study of the available information does not disclose any evidence to the effect that a foreign market can be established. The small quantity of flax seed sold to Peru and Persia in recent years was made possible by loans and credits extended to those countries by the United States. Such a market would normally be considered of a temporary character. In view of the localized nature of the fiber-flax industry, the reasoning in this section of this bulletin will be premised on the assumption that the market for Oregon fiber flax will continue to be a domestic market subject to continued competition with foreign fiber flax producers and with producers of other domestically produced fibers such as cotton, wool, hemp, and synthetic fibers.

Government Subsidies

The Oregon fiber-flax industry was developed as a subsidized industry. It existed prior to the outbreak of war in 1941 by virtue of the financial support given to the industry by the State and Federal Government, and the protection afforded by the Tariff Act of 1930, subject to reciprocal treaty rights after 1935. The assistance of the industry by the State was in the form of a direct financial contribution to the construction of three processing plants for operation by cooperative marketing associations, and by preferential tax treatment obtained by deeding the real property to the state of Oregon, but maintaining intact the use-right for a nominal annual rental charge. Federal assistance was made available to the industry prior to 1941 in the form of a direct contribution to the cost of the cooperative processing plants and subsidy payments to growers between 1936 and 1941 varying between $2.08 and $7.50 per ton of straw. It, therefore, appears that the fiber-flax industry came into being in Oregon under the sponsorship of the State Government and until 1941 was kept going largely by paternalistic State and Federal authority.

Wartime Demand Causes High Prices

The industry was stimulated by war demands and correspondingly high prices. The favorable demand-price situation which the industry encountered in 1940 resulted from the cessation of foreign fiber-flax imports and a simultaneous rise in demand for fiber-flax products. Eastern manufacturers who had relied mainly on imported fiber immediately sought to obtain all of the Oregon fiber-flax production, thereby placing the flax growers in one of the best bargaining positions they had ever attained. The question that is pertinent to this committee is whether the Oregon fiber-flax industry can adjust itself to a peacetime economy in which it must compete for markets on the basis of price and quality.

Trend of Consumption Downward

The per capita consumption of flax in the United States has decreased steadily since 1892. The per capita consumption of all apparel fibers and other fibers has increased. (Table 1). Several factors have contributed to this decline in the use of fiber-flax, the most important being the more rapid technological developments in the cotton, synthetic fiber, and woolen industries made possible through adequate financing of technical research into methods of increasing efficiency in production equipment and the development of new products and new uses for old products. The ability of the large cotton, synthetic fiber, and wool spinners and weavers to influence demand through advertising is very great, a condition well-illustrated by the power of such trade names as "Nylon" and "Celanese," comparatively new products in the synthetic apparel field. The failure of the younger generation to recognize and appreciate fine linen products stands as a direct contrast to the successful consumer advertising in other textile industries.

Table 1. ESTIMATED PER CAPITA CONSUMPTION OF FLAX FIBER AND TOTAL APPAREL FIBERS*

Period	Flax	Total apparel
	Pounds	*Pounds*
1892-94	.6	22.4
1895-99	.6	24.9
1900-04	.6	26.9
1905-09	.7	30.0
1910-14	.8	29.6
1915-19	.4	33.2
1920-24	.4	29.4
1925-29	.4	31.5
1930-34	.3	25.1
1935-39	.3	31.4
†1939	.3	34.3
†1940	.2	36.7

* Evans, Robert B. and Monachino, Rose F., *Trends in the Consumption of Fibers in the United States, 1892-1939,* U. S. Department of Agriculture, Bureau of Agricultural Chemistry and Engineering, April 1941.

† Estimates.

Domestic Mills Depended on Foreign Supplies Prior to 1941

The linen mills producing the bulk of domestically manufactured textiles have traditionally depended upon foreign countries for their flax fiber. (Table 2.) The linen mills developed under a semi-mercantilist theory of a free market for raw materials and a protected market for manufactured products. No particular effort was ever expended to develop a domestic source of supply of flax fiber. This was a natural result of competitive costs between American farmers and farmers in foreign countries, and the fact that American farmers were in a position to produce crops that yielded as high or higher net return without undertaking the burdensome labor incident to the harvesting of fiber-flax. The failure of private capital to become interested in the fiber-flax industry in this country can be explained almost entirely by the alternative opportunities available to it.

The Penitentiary Plant

The State of Oregon sponsored the fiber-flax industry in Oregon for a two-fold purpose, namely, (1) to encourage the development of a new industry, and (2) to meet the Penitentiary's need for a non-competitive industry which could be used as an outlet for convict labor. The Penitentiary flax fiber processing plant did afford to many Oregon Willamette Valley farmers an alternative opportunity for the use of their land. It provided also the basic experience required before the industry could expand. At no time, however, were the returns to farmers for their flax straw sufficiently high to cause any widespread shift to flax and away from other specialty crops. The Penitentiary plant likewise met the secondary objective of creating an outlet for convict labor. It provided the least competitive method of using such labor and at the same time did not compete with investment capital because there was none available for investment in such an enterprise. Regardless of the non-competitive character of the State plant, little promotional work was possible because of the fear of offending labor groups long opposed to the use of convict labor and a fear of incurring the opposition of the strong cotton and wool textile interests. The enterprise fostered by the State was obliged, therefore, to operate under the principle that the least conspicuous is sometimes the most successful.

Table 2. FLAX-LINE FIBER: DOMESTIC PRODUCTION AND IMPORTS

Year (Calendar)	Domestic production*	Imports†
	Tons‡	*Tons*‡
1933	345	3,221
1934	277	3,765
1935	256	3,771
1936	210	4,095
1937	240	4,500
1938	250	1,149
1939	220	4,126
1940	220	-------
1941	640	-------
1942	1,240	-------
1943	1,800	-------

* Source: See Table 3.
† Evans, Robert B. and Monachino, Rose F., *Trends in Consumption of Fiber in the United States, 1892-1939,* U. S. Department of Agriculture, Bureau of Agriculture Chemistry and Engineering, April 1941.
‡ 2,000 pounds.

Oregon's Production of Flax Fiber Small Prior to 1942

The available supply of Oregon-produced flax fiber was never large enough to be of interest to the manufacturers whose plant capacity caused them to depend on imports, thereby making it necessary for them to adapt their equipment to the grade and

Table 3. ESTIMATED ACREAGE, PRICE AND PRODUCTION OF FLAX* AND FLAX FIBER IN OREGON, 1925 TO 1943

Year	Area harvested	Net farm production	Net yield per acre	Farm price per ton	Per cent over 30 inches in length	Fiber scutched during calendar year† Line	Fiber scutched during calendar year† Tow	Fiber scutched during calendar year† Total	Top price per pound Sorted line	Top price per pound Scutching tow
	Acres	*Tons*	*Tons*		*Per cent*	*Tons*	*Tons*	*Tons*	*Cents*	*Cents*
1925	2,100	2,646	1.26	$31.60	74	....	....	....	....	....
1926	1,644	2,367	1.44	37.20	93	....	....	....	....	....
1927	2,100	3,802	1.81	34.85	84.5	....	....	....	....	....
1928	2,782	3,811	1.37	33.85	88.5	....	....	....	....	....
1929	3,462	5,955	1.72	34.65	96	....	....	....	....	....
1930	3,811	8,727	2.29	36.00	93.5	....	....	....	....	....
1931	1,793	3,012	1.68	23.35	37.5	297	207	504	20	4
1932	713	1,041	1.46	21.17	68	295	160	455	17	4
1933	461	940	2.04	19.41	99	345	133	478	21	5
1934	1,904	3,884	2.04	22.50	100	277	108	385	21½	5
1935	2,465‡	1,430	.58	16.30	37	256	199	455	23	5
1936	2,540	5,120	2.02	25.00	91	210	160§	370§	23	5½
1937	2,750	4,324	1.57	27.00	87	240	260§	500§	25	5½
1938	3,880	2,622	.68	20.00	23	250	240§	490§	25	5½
1939	3,900	5,600	1.44	35.70	59	220	200§	420§	28½	7
1940	7,300	8,615	1.18	55.50	62	220	200§	420§	58	10½
1941	11,000	23,825	2.16	....	87	640	500§	1,140§	58	11½
1942	18,000	37,000	2.06	....	81	1,240	860§	2,100§	58	13
1943	12,000	20,000	1.67	....	58	1,800	1,500§	3,300§	58	13
Year average			1.60							

* All data 1925 to 1935 inclusive courtesy of the State Flax Industry, Salem, and represent their production only. No other fiber-flax was produced in Oregon during this period except in 1935. (See ‡ below.) Farm acreage, production, and price data 1936 to 1943 courtesy of M. D. Thomas, Assistant Extension Economist, and have been published.

† Fiber production is mostly from crops grown one or two years preceding the year reported.

‡ Includes about 500 acres cut for seed and threshed on the farm and does not include 1200 acres contracted by the Champaign Paper Corp., New York, N. Y., and 100 acres contracted by the Farmers Flax Cooperative Association, Eugene, only part of which was harvested and none processed.

§ Tow production 1936 to 1943 estimated from the line-tow ratio obtained at the State Flax Industry, Salem, Oregon. Tow produced at other plants not recleaned and complete data were not available. In the State Flax Industry figures, the combings from the butts are included with the line and from the tips with the tow. Both tips and butts included with line from other plants.

quality of the imported fiber. Manufacturers require some assurance of a reliable and constant flow of raw materials. They are likewise in a position where they must demand a given quality in order to best utilize their machines which must be especially adapted to the product. A further consideration is that a supply at all times must be ample. Since 1925, the annual acreage under contract for flax production in Oregon has varied greatly. (Table 3.) In any case, the past variations in the amount of product available for market and in quality combined with the low output have prevented manufacturers from assuming the risk of depending too heavily on Oregon as a source of supply when they are relatively sure of their imported product. The production of line-fiber in Oregon in 1940 was 220 short tons. The production in 1944 is estimated as 2,500 short tons, which is equal to approximately two-thirds of the annual average consumption of line-fiber in the United States for the seven-year period 1933-1939. This level of output was developed under war conditions when imports were practically eliminated, but it has completely altered many of the problems facing the industry in the postwar period.

Production of Fiber-Flax Influenced by Prices of Alternative Crops

The increases and decreases in flax acreage are closely associated with the average price paid to growers. In an area such as the Willamette Valley, other specialty crops afford to the farmer an alternative use for his cropland. If the grower income from flax is sufficiently high to compete with other crops or the grower investment in specialized equipment is such that he cannot afford to shift to other crops, flax would continue to be produced, otherwise there will be a shift to new crops. Until the flax growers formed their cooperative processing plants in which they had some financial interest, shifting in and out of the flax production business was a common occurrence. With the formation of the cooperative processing plants, however, the in-and-out movement of growers has decreased considerably.

Foreign Competition

The ability of the fiber-flax industry to continue production during the postwar period will depend entirely upon one factor, namely, the ability of the growers to meet foreign competition. Foreign competition might be overcome either through technological improvements in harvesting and processing which would tend to lower unit costs or by economic controls over imports in the form of tariff regulation or subsidy. While progress is being made toward increasing machine efficiency and decreasing hand labor requirements, no radical change appears likely in the next few years that would not be equally available to foreign producers. On the other hand, the policy of the Federal Government may be to promote the industry as a part of its national defense program, in which case economic assistance would accrue to the industry in the form of direct or indirect subsidies or outright tariff barriers.

A market for flax-fiber by-products at reasonable prices would also tend toward more efficiency in plant operation, thereby reducing the unit overhead assignable to line-fiber. Under present conditions, however, it seems reasonable that any material expansion in the use of by-products will have to arise through the manufacture and sale of specialties, thereby avoiding many of the implications of direct price competition with other fibers.

Unless the Federal Government adopts a policy of fostering the fiber-flax industry as a part of the national defense program, reciprocal trade treaties might be used to lower the tariff protection afforded the Oregon fiber-flax industry under the Tariff Act of 1930. Our present war experience is showing that there are not many military products in which flax could be used for which satisfactory substitutes have not been found. There are, however, specific uses for flax fiber for which no acceptable substitute has been found. These are linen thread for use in the manufacture of leather shoes and coarse flax-fiber twine for the manufacture of fish nets.

Possible Outlet for Specialty Products

Any material increase in the demand for flax fiber will arise only as a result of an increase in the demand for specialty flax fiber products such as fine table linens and certain types of wearing apparel. The failure of the linen textile industry to cultivate a consumer demand for high grade products is most likely attributable to the fact that most all fine fabrics are imported while the American factories confine their activities to the manufacture of fabrics of lower quality and coarser weaves. The ability of producers to influence consumer choice of textiles has been amply demonstrated. Should the industry desire to expand its outlets by creating a demand for fine linens, some adjustments in the manufacturing techniques and the selection of fibers would be required. These adjustments would be warranted, however, provided the price of the product was sufficiently high to cover the cost of the additional labor involved in producing the higher quality product. On the other hand, there are many grades of linen fabrics now manufactured in this country for which the consumer demand in relation to other fabrics would appear very small.

The Oregon fiber-flax industry might be benefited materially if consumer demand for flax fiber products could be stimulated. This would entail a definite sales promotion campaign of an informational type conducted by the industry for the benefit of all groups interested in fiber-flax growing, processing, and manufacturing. Doubtlessly, the milling, processing, and growing interests in the flax industry would have to be brought together into a much closer working arrangement than that obtained in the past. If these industry adjustments are not feasible, the only apparent hope of maintaining the fiber-flax industry in Oregon will rest on some type of Federal or State aid which is not uncommon with the crops and commodities.

Possibilities for Federal Aid Small

The localized character of the Oregon fiber-flax industry and the small number of growers and workers interested in the welfare of the business preclude any possibility of substantial Federal aid. Inasmuch as the crop is produced primarily for out-of-state markets and is not considered essential to the economic well-being of the people of Oregon, it is doubtful whether State support can ever become anything more than mediocre.

Industry Policy Needed

A definite policy on the part of the Oregon fiber-flax industry during the postwar period is needed badly. Such a policy should be based upon the available facts relative to the technological and economic outlook for the Oregon industry. Adequate information is now at hand to evaluate the industry from a technological standpoint. A substantial body of historical economic data is available also to help in an economic interpretation. But the vital link to an accurate economic analysis is missing, namely, an understanding of the attitudes and plans of the large spinners and weavers who have traditionally imported flax fiber from Europe. Will this group be ready and willing to shift its demand to Oregon, and under what conditions? It is the responsibility of the industry to know the answer to this question in marketing.

RECAPITULATION

In preparing this report the committee has presented the material in considerable detail. This was done advisedly because as a whole the public is probably less familiar with the fiber-flax situation than with most other agricultural enterprises. In the committee deliberations, it was evident that even the members themselves were not thoroughly familiar with all phases of the problem. It was felt, too, that the economic importance of a flax plant to a community is sufficient to justify an extensive report. Accordingly the committee has attempted to include in this report both the presentation of the situation as it exists now, the problems involved, and the possibility for improvement under these categories: markets, production, processing, and quality. The problems in each of these fields have been indicated, and it now becomes possible to determine some of the relationships which exist.

Markets

Markets appear to be the vital link on which the entire flax industry in this state depends. It is also the point about which less can be stated definitely. It is the opinion of the committee that, without some assurance of a market, the improvement that can be made in production and in processing will have little ultimate effect on the permanency and the prosperity of the flax industry in Oregon

The market situation with fiber-flax can be summarized briefly as follows: Prior to the war period Oregon produced such a relatively small amount of flax fiber that the total supply was of little consequence in the market. The manufacturers of linen materials had to depend, therefore, largely upon imports to meet their requirements. Oregon's fiber production ranged from 200 to 300 tons annually from 1931 to 1940. It has since developed to a point where the potential production of existing facilities is from 2,500 to 3,000 tons of fiber annually. In other words, Oregon's position has changed from a producer supplying less than 5 per cent of the total manufacture requirements to an industry that can supply approximately 70 per cent.

The information that is missing in the present picture is the known attitude of the manufacturers themselves. It is of paramount importance to ascertain: first, whether the existing or potential quality of Oregon fiber is suitable to the manufacture; and second, whether the flax mills will be willing to break away from their dependence on imports provided Oregon-grown fiber is competitive in price and quality and is adequate to meet their requirements. Without this information which would give reasonable assurance of maintaining the industry at least on its present basis, the extension of research facilities in production and in processing may not be advisable from an economic standpoint.

Attention has been called to the possibility that competition from other crops might limit the acreage that farmers would plant to flax and to producer needs for current information relating to market prices and practices. Research directed toward determining cost of production, labor and capital requirements, and the returns in relation to commodities which might compete with it for acreage would be of great value. If this could be done, farmers would then have a measuring stick that would enable them to determine the prices which would enable them to grow flax. This would aid materially in establishing a needed stability.

It may be pertinent to point out here that the output of the fiber-flax industry has a value of from three to four million dollars annually. The marketing problem is one which affects every plant operating in the territory. The industry itself is large enough and has sufficient mutual interest to justify the formation of a strong trade association. Most of the processing plants have signified their intention to participate in a trade association, and the preliminary steps have been taken to effect such an organization. Unfortunately many of the plants entering into this association do not as yet realize the scope of the industry nor the magnitude of their problems. A strong, vigorous trade association composed of all plants operating in this territory could be extremely effective in establishing fiber marketing on a sound and permanent basis.

Production

If it can be assumed that a market will be available and that Oregon growers will not be discriminated against, then it can be assumed also that Oregon growers will have to meet vigorous foreign competition. In order to do this, it will be necessary for them to become more efficient in production. The research agencies of the United States Department of Agriculture and of the Oregon Agricultural Experiment Station should be directed in those channels which will permit greater economy in production. These objectives may be summarized as:

1. Variety selection for higher yields of fiber per acre.
2. Cultural practices that will improve the quality of straw and fiber produced.
3. Harvesting machinery with increased capacity per unit of labor.
4. Handling methods that assure delivery of the straw at the mill in good condition.

Processing

Fiber-flax differs from most farm commodities in that it must be processed before it can be sold. Because of this, the processing operation has been outlined in considerable detail, and the important problems have been outlined for each step in the process. It has been pointed out that more and better fiber might be obtained at less cost by:

1. Maintaining trained labor supply.

2. Segregation of straw according to physical characteristics affecting processing operations.

3. Use of the most efficient deseeding equipment.

4. Improving retting technique and facilities which will assure a high yield of good fiber.

5. The development of an artificial dryer that will produce a comparable or higher quality fiber at lower cost than sun drying.

6. Improvements in scutching machinery and technique for a high yield of line fiber with a reduction in tow.

7. Improvements in tow cleaning equipment.

Cooperative Extension Work in Agriculture and Home Economics
Wm. A. Schoenfeld, Director
Oregon State College and United States Department of Agriculture Cooperating
Printed and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914