Agricultural Processing — A Major Contribution to the North Dakota Economy

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New and renewed alliances are being formed across the United States in an effort to build an economic outreach program for both rural and urban America. Positive examples are institutions of higher education linking with traditional and nontraditional state, regional, and national firms, departments and agencies to deal with current and future economic challenges.

North Dakota, like other states, faces many economic challenges as it moves into the 21st century. On the upside are many positives to assist the state in taking progressive steps in expanding its economy. North Dakota has a long and well-established record in producing high quality raw products in both crops and livestock. Agriculture in the state will continue to modernize and adopt the latest technologies, a process that will see agriculture remain competitive, but impacted by a loss in farm numbers. The decline in farm numbers is a structural adjustment taking place across the United States in response to maintaining a competitive agricultural industry. The unfortunate loss of jobs from a decline in farm numbers can be offset by transforming high quality agricultural products into higher value-added products before leaving the state for domestic and foreign markets.

Agriculture in North Dakota represents the largest export base sector, generating the highest proportion of external money flows into the state. Agriculture, for example, accounted for 43 percent of total out-of-state sales in 1987. This sector then becomes a natural for leveraging economic expansion. Development and growth in higher value-added agricultural economic activities translates into new markets, new jobs, new investments, and new wealth for North Dakotans.

Agricultural processing and miscellaneous manufacturing have been relatively small within the state (8.6 percent of total out-of-state sales, 1987) but have shown excellent growth through 1981 (Figure 1).

The North Dakota Manufacturing Index closely parallels the Midwest Manufacturing Index. These indexes compare the experience of North Dakota with other midwest states, some of which are far more industrialized. Both economies have been experiencing the effects of wrenching changes of the early 1980s, but now show evidence of recovery. Continued growth for the state in agricultural processing and manufacturing is promising. North Dakota has many commodities that have a high value potential. Research and development opportunities exist for meeting a growing demand for new products with an upscale market. Some raw products will offer opportunities for North Dakotans to earn money in what has come to be known as "niche" agriculture. These markets are characterized as highly specialized, command high prices, and show very competitive returns to investors.

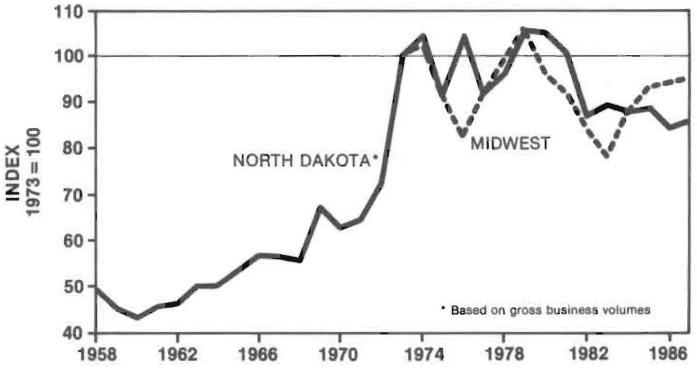

Figure 1. Index of ag processing and miscellaneous manufacturing, N.D., and Midwest Manufacturing Index.

The combined public and private economic development efforts in processing of raw agricultural products has led to a number of past successes in processing and manufacturing plant sitings and operations within the state. North Dakotans can look with pride to the successes in establishing sugarbeet processing, malting operations, oil seed crushing plants, the processing of pasta products, and various livestock processing operations. Other successes have been in manufacturing various lines of farm and nonfarm equipment as well as other agricultural and nonagricultural products. Likewise, basic and utilization research on the established crops grown in North Dakota including hard red spring and durum wheat, malting barley and other crops has been undertaken for many years at North Dakota State University.

Today more than ever before in agricultural states there is considerable interest in adding value to crops traditionally grown in a particular region as well as in growing alternate crops. Numerous institutes and centers of excellence have been established, primarily located at food science departments at universities. These centers, in general, have one or more of the following goals in mind:

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Enhance utilization research
Transfer information to industry
Aid in the development of new businesses
Provide technical and marketing assistance
Become stronger in chosen areas of specialization
Attract food processing to the state

To achieve these goals, various areas of fundamental and applied research have been identified. Included in the research will be attempts to find new uses for both traditional and alternate crops. Incorporation of added value to commodities traditionally sold in the unprocessed form will be a major objective. Adding value to a crop will result in the establishment of processing facilities, which will create new jobs for people and thereby improve the economic climate of the state.

Utilization will occur in both the food and non-food arena. Here at North Dakota State University efforts have already been initiated in this direction so as to improve the overall agricultural processing ventures in the state. Figure 2-4, taken from a report published in Food Technology in May 1988 on the growth and economic impact of the food processing industry in the United States, provides some interesting observations relevant to North Dakota.

As a result of a federal funding grant on alternate crops to the Agricultural Experiment Station, studies are already underway in the production and utilization area. The production research is dealing primarily with production of alternate crops whereas the utilization portion of this research has as its goal to develop, introduce and commercialize new products in order to diversify North Dakota agriculture.

Currently, several departments at NDSU are involved. This article outlines some of the research currently underway and being planned which could result in increased utilization of both traditional and new crops in the state.

The colleges, departments and principal investigators involved in this endeavor and the crop(s) being investigated are provided in Table 1. A summary of the research in progress or being planned follows.

Table 1. Agricultural utilization research at North Dakota State University.

College	Department	Principal Investigator	Crop Being Researched
Science and Mathematics	Chemistry	Dr. Boudjouk Dr. Sibi	Crambe
	Polymers and Coatings	Dr. Jones	Crambe
Home Economics	Food and Nutrition	Dr. Holm Dr. Chang Dr. Baldner-Shank	Sunflower Sunflower Flax
Agriculture	Crop and Weed Sciences	Dr. Hanzel	Sunflower
	Agricultural Economics	Dr. Helgeson	Sunflower
	Cereal Science and Food Technology	Dr. Hettiarachchy Dr. Khan Dr. Schwarz	Flax, Sunflower Edible beans Edible beans Barley, Oats

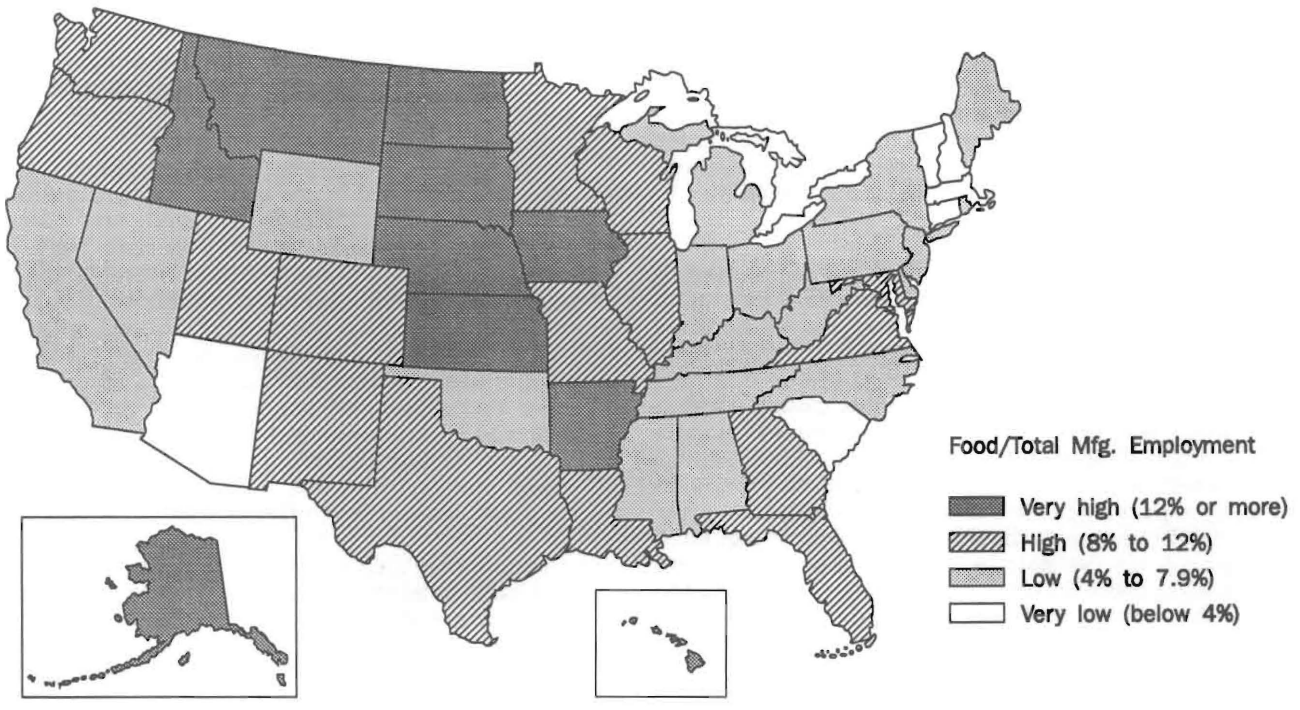

Figure 2. Importance of employment in the food industry, 1985.

In the chemistry and polymers and coatings departments, work has been underway for the past year on crambe. Crambe, an oilseed crop which is a good source of erucic acid, is being studied for various non-food uses. Brassylic and pelargonic acid are two acids which can be made from the oil in crambe. These acids are precursors to various products.

The chemistry department, under the direction of Drs. Boudjouk and Sibi, have prepared sample quantities of a compound derived from brassylic acid and ethylene glycol that possesses olfactory properties. The material has a very pleasant musk-like scent reminiscent of current scents on the market. The markets for these compounds vary from perfumes for individuals to scents incorporated in finished goods, such as packaging materials.

The same investigators are pursuing a new and efficient route to make precursors for nylon-13 from brassylic acid. The potential in this area is very large because of the escalating demand for feedstock nylons worldwide.

Dr. Frank Jones and graduate students David Chubin and Jim Kaczmarski in the polymers and coatings department are trying to demonstrate more uses for brassylic acid derived from crambe oil. Jones indicates that if there were a large, proven market, brassylic acid could be produced economically. As of yet the proven uses for brassylic acid are not large enough to interest investors. These researchers are trying to change this by finding more uses for this material and have demonstrated that it can be made into industrial coatings for such uses as coatings for metal furniture, appliances and metal siding. In addition the same group has made early prototypes of abrasion resistant elastomers for such uses as grain elevator linings, shoe soles and roller skate wheels.

Jones is also trying to interest large chemical companies in further evaluation of chemicals made from brassylic acid and is also working with U.S. and Japanese firms to try to interest them in building a brassylic acid plant at a site in North Dakota.

A project of particular interest in the utilization area is interdisciplinary in nature and involves the food and nutrition department in the College of Home Economics and the departments of agricultural economics, crop and weed sciences and cereal science and food technology in the College of Agriculture.

The major objective of this project is to extract, characterize and stabilize the anthocyanins from the purple-hulled sunflower. The anthocyanins pigments, which are red in color, would eventually be used as a replacement for the synthetic red dyes currently being used in the food and beverage industry. Dr. Edna Holm in food and nutrition is currently examining the various profiles of anthocyanins present in sunflower while Dr. Hettiarachchy of the cereal science and food technology department has been heavily involved in trying to stabilize the color of the red anthocyanin pigment extract obtained from the sunflower hull. Hettiarachchy is currently also involved with plans for bench and pilot plant scaleup of the process.

Dr. Helgeson will investigate the economic feasibility for commercialization of anthocyanin. Major thrusts of this research are directed as estimating domestic and foreign market potential for anthocyanin. Historical market shares for both synthetic and natural food colorants will be analyzed and forecasts made of potential market size looking five to 10 years into the future. Estimated processing costs and returns will be developed for a commercial-sized plant. This effort will involve establishing minimum processing plant size

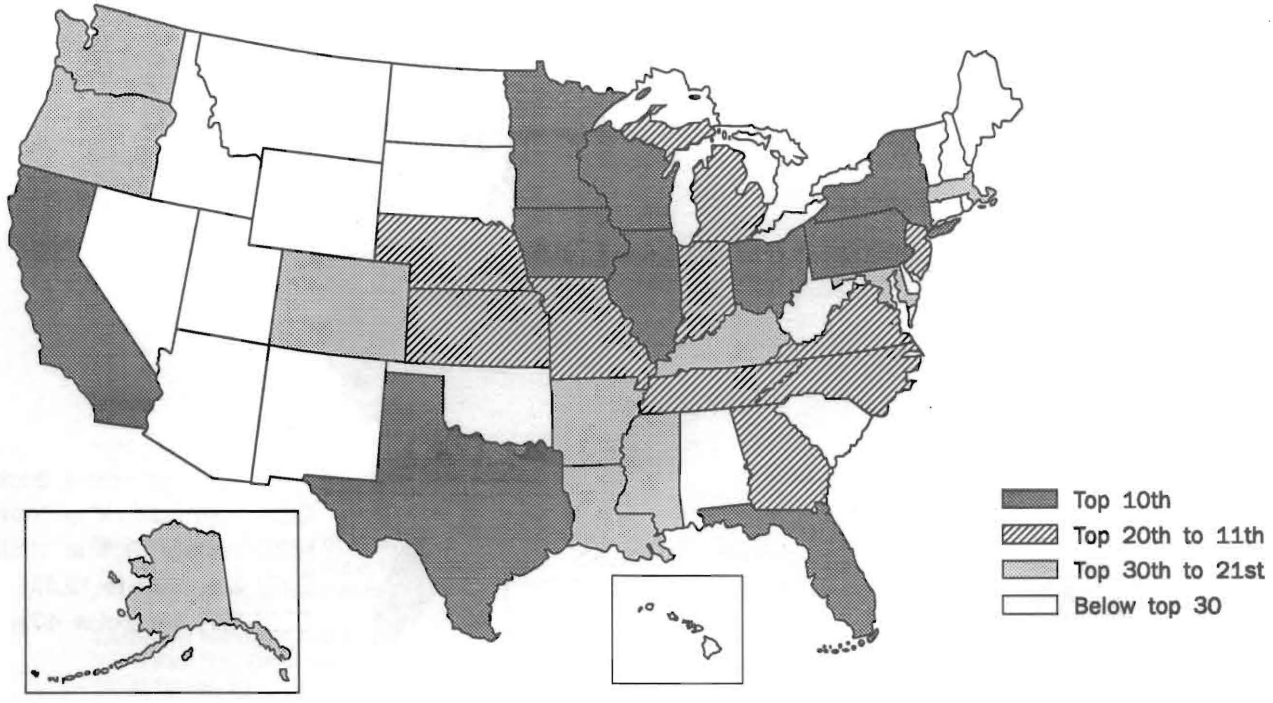

Figure 3. Rank of state by food processing shipments, 1982.

parameters for the purpose of estimating plant investment costs, operating costs, revenues, and net returns based on current market prices. Plant facility determination and associated costs and revenues provides an assessment of economic feasibility by analyzing the factors that directly affect a commercial-sized operation as related to estimated markets.

Dr. Hanzel of the crop and weed science department will be analyzing the purple-hulled sunflower from another perspective. Little is known about the expression of the purple-hulled trait when the genotypes are grown in different environments or when purple-hulled genotypes are put into hybrid combination with non-purple-hulled germplasm. It would be desirable if the anthocyanin pigments did not change when grown in different environments or when put into hybrid combination.

Hulls are available from plantings at approximately 10 environments over the past several years. The anthocyanin pigments will be extracted and analyzed using high performance liquid chromatography technology to determine if environment affects the expression of the purple pigment qualitatively and/or quantatively. In addition, hulls are available from various cross and backcross generations of matings between purple and non-purple sunflower lines. The anthocyanins of these progenies will be analyzed in a similar manner. The analyses of anthocyanin pigments will be done in cooperation with Dr. R.L. Harrold, department of animal and range sciences.

Natural antioxidant extracts from northern grown crops are being studied by Dr. Hettiarachchy and graduate student Sylvester Onyeneho of the cereal science and food technology department. The project is aimed at adding value by utilizing by-products as raw materials to obtain "natural" food ingredients. The objective is to replace synthetic material currently used in the food industry to prevent or minimize rancidity by a natural preservative. To date these workers have examined numerous by-products for antioxidant activity, including material such as flax hull, potato skins, wheat bran, navy and pinto bean hulls, and oat bran as sources of natural antioxidants. Navy bean hull and wheat bran appear to have the best potential. Research is in progress to optimize the product yield and to quantify the active antioxidant components. Antioxidants represent an estimated $2.0 billion in annual sales. Dr. Gabrielson of the microbiology department is currently examining if natural antioxidants from sunflower hulls can inhibit microbial growth.

Dr. Helgeson will conduct an economic feasibility analysis directed at estimating the domestic market potential for a natural antioxidant given current market consideration for synthetic antioxidants and developing trends related to market displacement potential for natural derived antioxidants.

Dr. Khalil Khan of the cereal science and food technology department is studying dry edible bean processing and utilization. The overall objective of this research project is to find new markets for utilizing dry edible beans besides the traditional canning and dry packaging markets. One possible area of expanded utilization is the food ingredient market. The ingredient area is being explored through milling of dry edible beans into flour and air-classifying the flour to obtain high fiber, high protein and high starch fractions. These fractions may be used in various food formulations to provide a particular nutritional and/or functional property.

The three bean fractions are also being evaluated by one of the most widely used and versatile technology called high

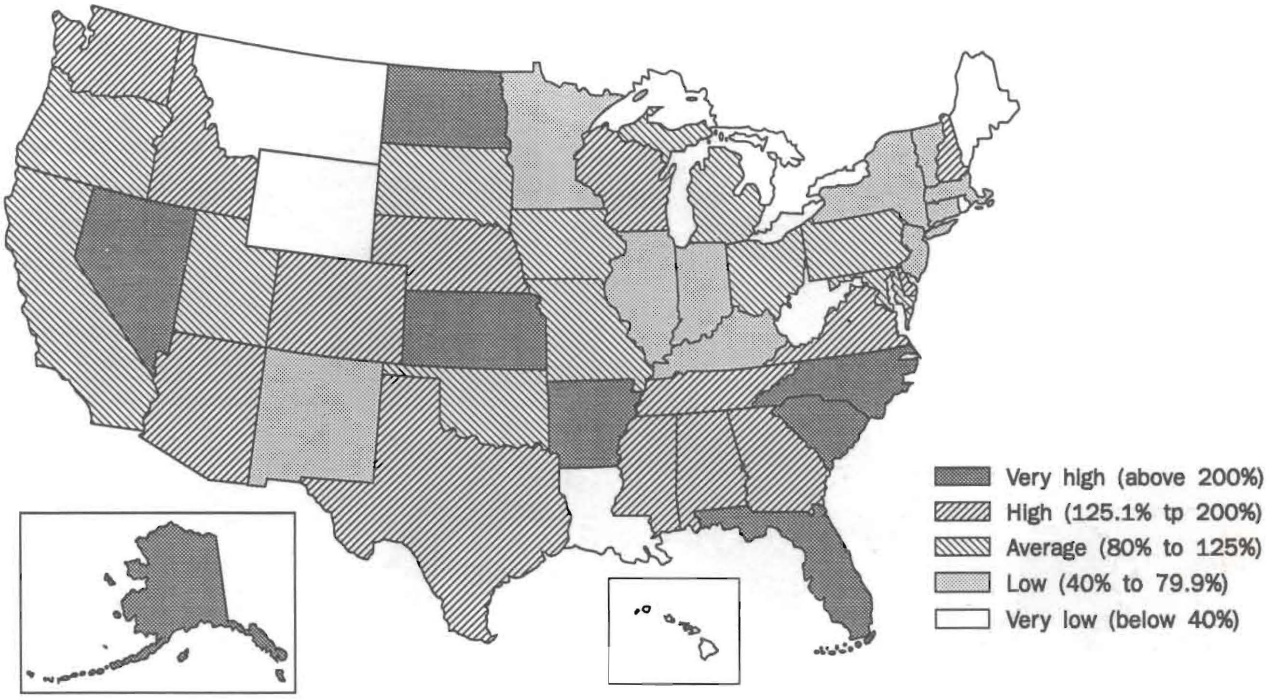

Figure 4. Real growth of food manufacturing production, 1963-1985.

temperature — short time (HT/ST) extrusion for possible use in manufacture of more nutritious snack foods. Today's consumers are becoming more aware of and demanding more nutritious snack food products. One attraction for pursuing the snack foods area is that it is a billion dollar industry.

In order to find a niche(s) for a new market(s), research on the physicochemical, nutritional and antinutritional, and functional properties of dry edible beans and their fractions must be undertaken. The information derived from this research would be very useful to scientists and food processors in planning strategies for potential new uses (markets) for dry edible beans.

Dr. Paul Schwarz of the cereal science and food technology department is initiating work in oats and barley utilization. The public has become increasingly aware of research which suggests that oat or barley products may reduce serum cholesterol levels when included in the diet at adequate levels. The food industry has responded with a wide range of new products. As research in this area progresses, the evidence seems to suggest the (1→3), (1→4) beta-D-glucan constituent(s) as the factor which influences cholesterol levels. It has been suggested that beta-D-glucans might be isolated from barley and employed as a food additive. However, to be economically feasible for the food producer, this isolate should display some unique and advantageous characteristic which is not present in the crude cereal flour.

A portion of the beta-D-glucans present in both oats and barley is water soluble. In solution the beta-D-glucans exist in a rigid ribbon-like conformation, and are thus capable of forming highly viscous solutions. These properties suggest possible use in food gum applications.

The objective of this research is to evaluate the rheological/flow properties of beta-D-glucans. Beta-D-glucans are to be isolated from barley or obtained commercially. The isolate will be chemically characterized. Rheological properties will be determined under a range of conditions including temperature, concentration, and the presence of other solutes. Attempts will be made to alter the functionality of the beta-D-glucan through chemical modification. Based on the results of this work the functionality of beta-D-glucans in model food systems may be evaluated.

Work has been initiated with flax in the departments of food and nutrition and cereal science and food technology. Dr. Glenace Baldner-Shank of the food and nutrition department will determine the efficacy of crushed flaxseed (as a source of omega-3-fatty acids) to alter blood lipids when incorporated into a bakery product.

In the cereal science and food technology department, Dr. Navam Hettiarachchy will examine the stability of ground flax under various processing and storage conditions. Conditions will be optimized to obtain a product that would be stable for product utilization and consequently provide a good source of omega-3-fatty acids. Work is also in progress to determine omega-3-fatty acid levels in various cultivars of flax.

Research on the utilization of pectin from the sunflower head will be initiated by Dr. Sam Chang of the food and nutrition department. The extraction, characterization and gelling properties of this material will be studied.

Investing in the future by supporting principal thrusts in value-added agricultural research and development can produce results that will not only create growth, but will serve to diversify the economic base and protect against pronounced economic cyclical swings in the state's economy. Value-added research can help keep profits at home and the bottom line not only becomes net profits for businesses, but new markets, new jobs, new investment opportunities, and increased wealth accumulation for North Dakota.

REFERENCES

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Continued from page 2

panded efforts can lead to new and exciting processing industries in our state. Many potential non-food uses for agricultural raw materials offer additional large and expanding market potential. Products such as biodegradable plastics, high performance lubricants, plastics, and coatings made from starches and oils produced in North Dakota farms are just a few examples of what research will develop in the years ahead. If we are to participate in the new industrialization of agriculture in this state, we must provide adequate support to the research enterprise to develop the technology and assist private entrepreneurs in commercializing the new technologies as they emerge.

There is a significant effort in Congress to pass legislation that will provide federal support to assist value-added industries in rural areas. North Dakota research and development agencies need to be positioned with state support to participate in this program. Economic development of the agricultural resource base can and will happen if state resources are properly positioned to take advantage of new opportunities.