Crambe Production and Processing: A Case Study of the Effects on Rural Areas in North Dakota

by

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Abstract: Crambe is a new industrial oilseed being grown in North Dakota. An input-output model was used in this analysis to estimate the economic effects of crambe production, the construction of an oilseed processing plant to handle the crop, and the crushing of the crop in a 15-county region in central North Dakota. The results indicate that an estimated gain of nearly $10 million in total sales and 42 new wage and salary jobs will be added to the region as a direct result of the increase in the production and processing of the 1997 crambe crop. Through local purchases of supplies and the spending of crambe-related income, the industry will generate an estimated additional $2.8 million in total sales and 46 wage and salary jobs. Building the plant added an estimated 46 temporary construction positions in the region, which generated an estimated increase of $2.2 million in sales and another 40 jobs in various industries as the workers spent their wages.

Keywords: Crambe, North Dakota, industrial crops, oilseed processing, regional development.

Over the last 10 to 15 years, a few new industrial crops have been developed in the United States and are now under commercial production. Kenaf, an annual fiber crop, is being produced in the southern regions of this country. Two new industrial oilseeds, crambe and meadowfoam, are grown in North Dakota and Oregon, respectively.

The development, commercialization, and adoption of new crops can provide farmers with additional cropping options. Crop diversification can minimize the risk of uncertain markets and production problems, such as adverse weather conditions and disease outbreaks. Some new crops may fill a rotational need that has multiyear benefits. For example, farmers in North Dakota prefer to use crambe as a broadleaf crop in rotation with small grains because it does not have the insect problems often seen with canola and sunflowers, yet it is not susceptible to the weeds and diseases plaguing small grains. Another example is meadowfoam, which has given farmers in Oregon's Willamette Valley an alternative crop when grass-seed production is no longer viable due to weed problems or other reasons.

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Potential Rural Impacts of New Industrial Crops

Although these new crops may bring about only marginal changes in farm income and agricultural output at the national level, they may have a greater impact at the local level. The development and commercialization of new industrial crops can affect rural economies in several important ways. First, farm income could rise as a result of new crop opportunities. Second, if farm production increases, the level of inputs, transportation, and storage may increase. Jobs in farm-related industries could be created, such as in processing the raw commodities and producing products. Finally, rural employment also may rise because of the multiplier effects of enhanced farm income, increased demand for agricultural inputs, and the establishment or expansion of processing and manufacturing facilities that use agricultural commodities.

The benefits to rural communities depend in part on the industrial mix of the community. Rural areas with a large agricultural base are likely to experience a greater impact due to changes in farm employment, income, and land values than rural areas that specialize in nonagricultural activities (2). Approximately 24 percent of all nonmetropolitan counties are classified by the Economic Research Service as farming-dependent, deriving at least 20 percent of their total labor and proprietor income from farming. Farming-dependent counties are primarily concentrated in the Great Plains, spanning from North Dakota to the Texas Panhandle.

Even if a new industrial crop is produced in a nonmetropolitan area, not all the potential income and job benefits will be realized. For instance, farm employment may not change with the introduction of a new crop, particularly if it is similar to those currently produced. Also, the higher value-added benefits may not be captured in the area. A firm's decision on where to locate its processing and/or manufacturing facility is based on a region's resource base, transportation costs of the raw commodity relative to the processed product, and the availability of skilled labor. Rural areas generally have a comparative advantage over urban areas in terms of availability of natural resources, lower tax rates, and less expensive land and labor costs. However, some processing plants, particularly for those crops that are less costly to transport and store, are located in metropolitan areas. Also, some industries that use agricultural raw materials, such as the chemical and rubber industries, are located in metropolitan regions because they rely on highly skilled labor and technicians. In these situations, metropolitan areas may receive more benefits from industrial crops and products than nonmetropolitan areas (2).

If the development of new industrial crops is to be used as a rural development strategy, it may be useful to develop criteria for which new crops would likely cause the greatest net gain for a region. A new crop should provide some benefit to farmers by fitting into a crop rotation, having the ability to be grown on otherwise unproductive land, or replacing a lower valued crop. Ideally, the region should also capture some of the frontward linkages of the new agricultural products, such as processing and marketing enterprises. This case study illustrates how a rural area is affected by a new industrial crop. The study looks at crambe production and processing in rural North Dakota, showing a region's success in both producing a new industrial crop and participating in the enhancement of the product.

Crambe Uses and Production In North Dakota

Crambe is an annual oilseed crop first introduced in the United States in 1940. Sustained commercial production began in 1990 in central North Dakota. The crop is grown for its inedible oil, which contains high amounts of erucic acid, a 22-carbon fatty acid. Erucic acid is used to make intermediate chemicals, such as slip and antiblock agents, emollients, and surfactants, that are used in the manufacture of such items as plastic bags, cosmetics, personal-care products, and laundry detergents (1). Crambe oil could potentially be used in paints and coatings, nylon-1313, plastics, and hard waxes (3).

Industrial rapeseed is the traditional source of erucic acid for the world market, but in the United States, crambe has begun to tap into this market. Industrial rapeseed and crambe are the only commercial sources of erucic acid (1). The United States currently imports about 40 million pounds of industrial rapeseed oil, primarily from Canada and Eastern Europe, worth about $10 million annually. A small amount of industrial rapeseed is also grown in the Pacific Northwest.

The American Renewable Oil Association, an association of crambe growers, contracted with 435 producers to grow crambe on 50,000 acres in 1997, an increase of 28,000 acres from the previous year. The number of acres contracted is the estimated amount required to meet the domestic demand for crambe oil. All of the acreage is in North Dakota, with much of the production concentrated in the center of the state. In addition to crambe production, AgGrow Oils, a grower-owned company, has begun construction of an $8-million oilseed-crushing plant in Foster County, North Dakota. The plant is a full-press, mechanical processing facility that is scheduled to begin operation in November 1997 processing this year's crambe crop. The company estimates the plant will be able to handle 200 tons of seed per day at startup. The plant will process other novel oilseeds, such as high-oleic sunflower and safflower, flax, and possibly specialty canolas, as well as crambe. AgGrow Oils plans to add a refining system to the plant in subsequent years.

Using an Input-Output Model To Assess Crambe's Effects

To analyze the regional effects of crambe production and processing, a study area of 15 nonmetropolitan counties was defined. The study area encompasses the major crambe growing areas and the related oilseed crushing plant (figure A-1). Total population in the region is 149,000, with an average income of $40,382 per household (table A-1). Nearly 24 percent of the 86,538 jobs are in the services sector, which accounts for the largest share of the region's employment. Although agricultural employment makes up only 15 percent of regional employment, 8 of the 15 counties are considered farming-dependent. The region produces 30 percent of North Dakota's barley crop and 47 percent of the state's sunflower seeds, which is 11 percent of the Nation's barley crop and more than 26 percent of all domestically grown sunflower seeds (table A-2).

Figure A-1
North Dakota Study Region

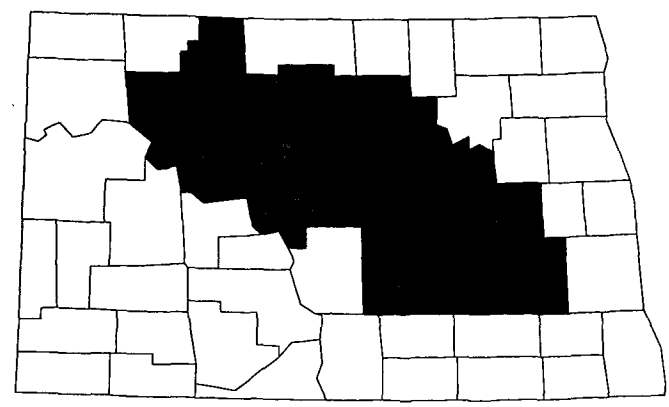

Table A-1–Economic characteristics of the North Dakota study region

Item	15-county study area	Share of North Dakota total
	Number	Percent
Population	149,700	23.5
Income per household 1/	$40,382	N.A.
Total employment	86,538	21.6
Agriculture	12,893	29.2
Mining	446	19.4
Construction	4,287	17.2
Manufacturing	3,414	16.7
Transportation, communication, and public utilities	4,048	20.7
Trade	17,929	20.0
Finance, insurance, and real estate	3,822	18.3
Services	20,741	20.8
Government services	18,636	24.3

N.A. = Not available. 1/ Includes noncash benefits.

Source: IMPLAN Pro Database, Minnesota IMPLAN Group, Stillwater, MN, 1996.

Table A-2–Agricultural characteristics of the North Dakota study region

Item	Regional value	Share of North Dakota total	Share of national total
	1,000 acres	Percent	
Acreage			
Land in farms	11,462	29.1	1.2
Total cropland	8,837	32.2	2.0
Harvested cropland	6,062	31.5	2.1
Irrigated land	37	19.8	0.1
	$1,000		
Value			
Agricultural production	715,074	26.0	0.4
Crops sold	523,719	25.8	0.7
Livestock sold	191,326	26.8	0.2
	1,000 bushels		
Production			
Barley	43,259	30.0	10.9
Corn	2,739	7.3	1/
Wheat	126,631	30.9	5.7
Oats	10,676	31.9	4.3
	1,000 tons		
Hay	992	30.4	0.8
	1,000 pounds		
Sunflowers	589,288	46.8	26.3

1/ Less than 0.1 percent.

Source: 1992 Census of Agriculture, U.S. Department of Commerce, Bureau of the Census, Washington, DC, 1994.

The effects of crambe production and its related enterprises on the overall economy of the central North Dakota study area are estimated using a regional input-output model. Input-output provides a framework in which to collect, categorize, and analyze data on the interindustry structure and interdependencies of a region's economy. Input-output models estimate the direct, indirect, and induced impacts from a final demand change on a region. In this case study, the direct effects are the sales, employment, and value added generated directly by crambe production and the construction and operation of an oilseed processing plant. Indirect impacts are the sales, employment, and value added that result from other firms in the local economy selling to the crambe enterprises, such as the agricultural input industries, agricultural services, and wholesalers. Induced effects or impacts are the sales, employment, and value added generated from the earnings of the workers in the newly created jobs as the earnings are spent in the North Dakota study region.

The analysis is performed within the framework of the 1993 Input-Output Model for Planning and Analysis (IMPLAN) Pro version. This model provides for county-level analysis from 528 industry sectors, similar in detail to the three-digit Standard Industrial Classification codes for most industries. The ability to assess a change in the overall economic activity of a region as a result of some change in one or several economic activities is the appeal of using a model like IMPLAN.

Estimating the Value of Crambe Production And Processing

The first task in estimating the impacts of crambe on the North Dakota study region was to determine the size of the crop, its value to the growers, and the value of the processed oil and meal. First, it is assumed that 90 percent of the 50,000 contracted acres in 1997 will be harvested, i.e., a 10-percent loss will occur due to weather, disease, or other factors, which leaves 45,000 harvested acres. Multiplying 45,000 by the estimated average yield of 1,350 pounds per acre results in a total crambe crop of 60.75 million pounds. Given the contracted price of 10.1 cents per pound, the value of the crambe crop is estimated to be $6.136 million.

Industry sources indicate that an 82.6-percent recovery rate of crambe oil and a 98-percent recovery rate for the meal are reasonable estimates for a mechanical processing facility like the Foster County plant. Crambe seeds contain 35 percent oil (4); therefore, there are 21.263 million pounds of oil in 60.75 million pounds of crambe seed. However, only an estimated 82.6 percent is recovered, or 17.563 million pounds of oil. Subtracting the pounds of extracted oil from the total amount of crambe seed yields 43.187 million pounds of crambe meal. Using the estimated 98-percent recovery rate, the output of crambe meal is about 42.323 million pounds. The total loss rate for crambe processing at this plant is anticipated to be 1.4 percent.

Prices for crambe oil and meal are not available, so price ranges of 28 to 35 cents per pound of oil and $75 to $100 per ton of meal are used as best estimates, based on industry analysts' forecasts. Prices for crambe and industrial rapeseed oil are likely to vary within the range depending on the

availability of world supplies. If supplies are adequate, prices may be in the low end of the range. However, if supplies tighten, prices may rise. The price of crambe meal is probably about one-third the price of soybean meal. Crambe meal can only be fed in limited quantities to beef cattle, as per U.S. Food and Drug Administration regulations, and feed formulators may not be familiar with it. However, mechanical processing leaves more residual oil in the meal, giving it a higher feed-energy value than meal from solvent extraction. Given the volumes cited above, the value of the crambe oil is estimated at $4.918 to $6.147 million and the meal at $1.587 to $2.116 million. The value of the two products together is $6.505 to $8.263 million.

Estimating the Impact of Crambe Production

The size of the impact of crambe production on the North Dakota study area is estimated under two different scenarios. The first scenario assumes the 28,000-acre increase in crambe acreage was on land not previously in crop production. The second scenario assumes the increased crambe acreage displaced another crop that would have otherwise been grown on the land. In this case, the income and employment gains from increased crambe production are offset by the loss of the foregone income and employment from the production of the crop that crambe displaced.

The estimated $6.1 million sales of the 1997 crambe crop is up $2.5 million from 1996's $3.6 million crop. This $2.5-million increase was used to estimate the total economic impacts of the expansion of crambe production on the North Dakota study area under the first scenario. The growth in crambe output alone translates into direct economic impacts of $1.2 million value added and the creation of 29 new wage and salary jobs (table A-3). Value added, which includes employee compensation, proprietary income, and indirect business taxes, is a measure of the value of goods and services produced by the crambe growers. When indirect and induced effects are calculated and added onto the direct effects, the total economic impacts of increased crambe production are $3.6 million in total sales, $1.8 million in value added, and 48 new jobs.

Table A-3--Economic impacts of expanded crambe production, 1997-98

Impacts	Sales	Value added	Number of jobs
	Million dollars		
Scenario I			
Direct	2.5	1.2	29
Indirect and induced	1.1	0.6	19
Total	3.6	1.8	48
Scenario II			
Direct	1.3	0.6	15
Indirect and induced	0.5	0.3	9
Total	1.8	0.9	24

Under the second scenario, it is assumed the increased crambe acreage came from canola acreage. Canola was chosen as the displaced crop because it is the most profitable crop after crambe in the north central North Dakota region. The estimated net return of $83.04 per acre from crambe production in 1997 far exceeds the projections for other crops grown in the region (table A-4). Given the $44.21 net returns per acre for canola production, total sales of canola from 28,000 acres are estimated at $1.2 million. An impact analysis on canola reveals that the loss of $1.2 million in sales from canola production would reduce total sales by $1.8 million, with losses of $900,000 in total value added and 24 wage and salary jobs, including induced and indirect effects. Therefore, the gains from crambe production under this scenario are roughly half the size of those under the first scenario. The difference would be even greater if crambe were substituted for a crop less profitable than canola. Aside from crambe's profitability, farmers also benefit by having another crop to put into their crop rotations, an advantage not captured in this analysis.

Assessing the Effects of the Processing Plant

A similar impact analysis was performed to look at the effects on the 15-county study area from the construction of an $8-million oilseed processing plant. Of the $8-million outlay for the plant, an estimated $3.5 million is to be spent on processing machinery, $4 million on construction materials and labor, and $0.5 million on engineering and technical services. The total output effect is estimated at over $10 million and 86 full- and part-time jobs added to the region's economy during construction (table A-5). Because building the plant is a one-time shock to the region, these effects are not expected to be permanent.

Table A-4--Estimated net returns of selected crops in north central North Dakota, 1997

Crop	Returns to land, labor, and management
	Dollars per acre
Crambe	83.04
Canola	44.21
Alfalfa (established)	42.94
Buckwheat	41.16
Sunflower (confectionary)	39.61
Winter wheat	31.12
Barley	15.51
Sunflower (oil)	11.93
Oats	-6.99

Source: Projected 1997 Crop Budgets: North Central North Dakota, North Dakota State University Extension Service, Fargo, ND, 1997.

Table A-5--Economic impacts of constructing a new oilseed crushing plant, 1997-98

Impacts	Sales	Value added	Number of jobs
	Million dollars		
Direct	8.0	1.7	46
Indirect and induced	2.2	1.3	40
Total	10.2	3.0	86

The last phase of the analysis is to examine the impacts associated with the oilseed-crushing plant. In the first year of operation, the plant will process the 1997 crambe crop, which is estimated to be nearly 60.1 million pounds. The value of production from the plant is difficult to determine because prices for crambe oil and meal are proprietary. Nevertheless, the direct output is calculated to be about $7.4 million, the midpoint of the estimated values of oil and meal determined earlier. Including indirect and induced effects, the total value added impact from crambe processing is estimated at $9.1 million, with a possible increase of 40 new jobs (table A-6).

Under the first scenario, the combined direct effect from crambe production, the construction of the processing plant, and the crushing of the 1997 crambe crop is estimated at $17.9 million and an added 88 new jobs in the North Dakota study region (table A-7). Adding the indirect and the induced effects accounts for a nearly $23-million impact on total output and an increase of 174 jobs. Total impacts are not estimated for the second scenario given the uncertainty of the alternative uses of the land used for crambe expansion.

The added jobs come from different economic sectors. Direct job impacts occur in the agricultural, construction, manufacturing, and services sectors (table A-8). The indirect and induced effects show job gains mainly in the trade and services sectors. Most of the new trade jobs are in wholesale trade and eating and drinking establishments, while the model predicts that hospitals account for most of the new service jobs. When total jobs are considered, 24 percent are in services and 22 percent are in construction.

The employment and income impacts from crambe production will be sustainable for the North Dakota study region if the demand for crambe does not fluctuate significantly. Industry sources estimate that about 50,000 acres of crambe would supply market clearing levels of crambe oil. Once the Foster County processing plant reaches full-scale operation of processing other oilseeds in addition to crambe, employment in this value-added industry will likely increase beyond the estimates in this analysis.

Table A-6--Economic impacts of new plant operation, 1997-98

Impacts	Sales	Value added	Number of jobs
	Million dollars		
Direct	7.4	1.2	13
Indirect and induced	1.7	1.0	27
Total	9.1	2.2	40

Table A-7--Combined economic impacts of crambe production and plant construction and operation, 1997-98

Impacts	Sales	Value added	Number of jobs
	Million dollars		
Direct	17.9	4.1	88
Indirect and induced	5.0	2.9	86
Total	22.9	7.0	174

Conclusions

The development of new industrial crops may result in modest rural employment and income growth in agriculturally related industries. Choosing new crops that can attract related industries to a region, such as oilseed crushing, is key to using industrial demand as a tool for rural development.

The results of this study demonstrate the importance of crambe to a farming-dependent region of North Dakota. A full 42 wage and salary jobs were added to the area as a direct result of the increase in the production and processing of crambe. Through local purchases of supplies and the spending of crambe-related income, the industry generates another 46 wage and salary jobs. The region will enjoy the added benefit of the construction activity while the plant is being built, temporarily adding 46 new positions and generating another 40 jobs in various industries as the workers spend their wages.

Table A-8--Combined employment impacts of crambe enterprises, 1997-98

Economic sector	Direct job impacts	Indirect and induced impacts	Total job impacts
		Number	
Agriculture	29	3	32
Mining	0	0	0
Construction	36	2	38
Manufacturing	13	3	16
Transportation, communications, and public utilities	0	8	8
Trade	0	30	30
Finance, insurance, and real estate	0	9	9
Services	10	30	41
Government services	0	1	0
Total	88	86	174
		Percent	
Agriculture	33	4	18
Mining	0	0	0
Construction	41	2	22
Manufacturing	15	4	9
Transportation, communications, and public utilities	0	9	5
Trade	0	35	17
Finance, insurance, and real estate	0	10	5
Services	11	36	24
Government services	0	0	0
Total	100	100	100

The crambe case study also underscores the importance of value-added industries to the economy. The higher wage jobs in such industries provide opportunities for nonmetropolitan residents, thereby aiding in the retention of population in rural areas.

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