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Industrial Uses of Agricultural Products Such as Crambe Play a Role in Rural Community Development

Growing public concern about pollution and the environment has sparked interest in industrial uses of agricultural products. Industrial uses of these products can provide farmers with new market opportunities. Expanding industrial demand for farm products may boost farm income and can restore economic opportunity in rural communities by attracting value-added industries. For example, increased crambe production and the construction of a new oilseed processing plant may bring employment and income growth to rural North Dakota.

Agriculture is most often associated with food production, but many agricultural products can also be used as inputs into the manufacture of industrial products and consumer goods. Nonfood and nonfeed applications of agricultural products include printing inks made from soybeans and biodegradable plastics made from corn starch. New industrial crops, hereafter referred to as new crops, are those not traditionally grown in the United States and include crambe, an oilseed crop used in the manufacture of plastic bags and transmission fluid; jojoba, a perennial crop native to Arizona, California, and Mexico, used mostly by the cosmetics industry; and kenaf, an annual fiber crop used to make pulp and paper products.

Over the past century, interest in developing new crops and new ways to use traditional crops has intensified. Finding substitutes for commodities currently in use can cut U.S. dependence on foreign imports, replace critical materials in short supply during wartime, and replace products that harm the environment with environmentally sound ones. Technological advances have expanded the ability to derive new, innovative products from raw materials.

One of the issues facing the development and commercialization of industrial crops and products is competition with less expensive petroleum-based products.

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Petroleum-based products are almost always less expensive than agricultural products, but their market price may not completely reflect their true cost to society. Air pollution from fossil fuels, and the increasing cost to dispose of nondegradable products, are not captured in the price of the goods. On the other hand, agricultural products, which are renewable, offer nonmonetary benefits to society that are often undervalued. This type of market failure justifies a further look into the benefits of industrial uses of agriculture.

Research on Industrial Crops Reveals Potential Benefits to Producers, Society

The development, commercialization, and adoption of new crops can provide more planting alternatives to farmers, increase commodity prices and farm income, and lead to local employment and income growth. Most studies of industrial crops and products conclude that these benefits are currently small, but the impact may be larger if the returns from production of new crops approximate those of traditional crops, or if manufacturers substitute agricultural commodities for traditional inputs. Finally, the addition of new crops to the farmers' rotation can minimize the risk of adverse weather conditions and uncertain markets.

Proponents of new crops also tout environmental benefits, such as the development of crops that are better suited to certain environments. For example, guayule, a desert-adapted shrub containing natural rubber, and jojoba are both drought-tolerant and could reduce the amount of

irrigation needed in production. This is particularly important to the Southwest and Plains States, where competing demands for water use are of growing concern (OTA, 1991; USDA, 1992). Some new crops also fit well in rotation with traditional crops, such as industrial rapeseed in rotation with corn and soybeans, which can minimize soil erosion and naturally control weeds and pests.

Environmental benefits may also be realized from industrial uses of traditional crops. Alternative fuel use, such as ethanol and biodiesel (a diesel-type fuel made from oils extracted from animal fats or from oilseeds and plants), offers air quality advantages over fossil fuels. In addition, the use of biodegradable plastics made from corn starch could alleviate waste disposal problems. However, these benefits may be outweighed by the environmental costs of increased crop production and new manufacturing processes.

Industrial crops and products may substitute for goods currently imported, potentially adding $15-$20 billion to U.S. farm income (USDA, 1992). In addition, high-value industrial exports could replace some low-value bulk commodity exports (OTA, 1991). Finally, industrial crops and products can reduce the Nation's reliance on foreign supply of strategic and essential materials, such as petroleum and natural rubber (OTA, 1991; USDA, 1992). These domestic substitutes include alternative fuels and starch-based materials in plastics production, and guayule as a source of natural rubber.

Industrial Crops and Products Could Have Greatest Impact on Rural America

Despite the potential benefits of industrial crops and products for society, they may bring about only marginal changes in farm income and agricultural output at the national level, particularly in the early stages of crop production. However, there may be greater impacts at the local level and in rural communities.

The development and commercialization of new industrial crops and uses for traditional crops can affect rural economies in several ways. First, farm income could rise as a result of new crop opportunities and/or increased demand for existing crops. Second, if farm production increases, the level of inputs, transportation, and storage will also increase. Jobs in farm-related industries, such as in the processing of raw commodities and the production of new products, could be created. Finally, rural employment may also 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 from the development or enhancement of industrial crops and products 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 value than are rural areas that specialize in nonagricultural activities (OTA, 1991). Approximately 24 percent of all nonmetropolitan counties are classified by ERS as farming-dependent, deriving at least 20 percent of their total labor and proprietor income from farming. These counties are primarily concentrated in the Great Plains, spanning North Dakota to the Texas Panhandle, and may best accommodate industrial crops and products development.

However, even when nonmetro areas show potential for success in the development of industrial crops and products, not all of the potential income and job benefits will be realized. For instance, expansion in agricultural production is often attributed to technological change and increased productivity, and does not always translate into more jobs on the farm. Therefore, even when more crops are produced, because industrial uses have caused an increased demand for traditional crops or if farmers begin growing new crops, employment in farm production will not necessarily rise. And, when gains from the expansion of industrial crops and products are realized, the higher valued benefits may not all be captured on site. A firm's location decision 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 an advantage over urban areas in availability of natural resources, lower tax rates, and less expensive land and labor costs. However, some commodity processing plants, particularly for those crops that cost less to transport and store, are located in metro areas. And some industries targeted as potential users of new agro-industrial commodities, such as the chemical and rubber industries, are also located in metro regions because they rely on highly skilled labor and technicians. In these situations, metro areas may receive more benefits from industrial crops and products than nonmetro areas (OTA).

If the development of new industrial crops is to be used as a rural development growth strategy, it may be useful to develop criteria for which new crops or enhancement of traditional crops for industrial uses would likely cause the greatest net gain for a region. A new crop should provide some benefit to farmers in the region 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. Below is a case study that illustrates how a rural area is affected by the creation or enhancement of industrial crops and products.

An Increase in Crambe Production and Processing Boosts Income in Rural 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 (Glaser, 1996). Crambe oil could potentially be used in paints and coatings, nylon-1313, plastics, and hard waxes (USDA, 1993).

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 (Glaser). The United States currently imports about 40 million pounds of rapeseed oil, primarily from Canada and Eastern Europe, worth about $10 million annually. A small amount of rapeseed is also grown in the Pacific Northwest. It is estimated that an increase in domestic production of crambe from 22,000 acres in 1996 to about 50,000 acres would replace rapeseed oil imports (USDA, 1993).

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. The plant is a full-press, mechanical processing facility and is scheduled to begin operation in November 1997, processing this year's crambe crop. John Gardner, an agronomist at AgGrow Oils, estimates production at 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 double the plant's capacity in 1998 and expects to process 250,000 acres of oilseed crops from North Dakota. The firm also anticipates adding a refining system to the plant in subsequent years.

To analyze the regional effects of crambe production and processing, a study area of 15 nonmetro counties was defined. The study area encompasses the major crambe-growing areas and the related oilseed crushing plant (fig. 1). Total population in the region is 149,700, with income of $40,382 per household (table 1). Nearly 24 percent of the 86,538 jobs are in the services sector, the region's largest employer. Although agricultural employment makes up only 15 percent of regional employment, 8 out of the 15 counties are considered farming-dependent. The region produces 11 percent of the Nation's barley crop and more than 26 percent of all sunflower seeds (table 2).

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. An input-output model was chosen for its ability to estimate the importance of agriculture to a region by estimating regional multipliers (see box "What is Input-Output Analysis?").

The value of the 1997 crambe crop was estimated at $6.1 million, up $2.5 million from the 1996 crop-year value of $3.6 million (see box "Estimating the Value of Crambe Production and Processing" for details on estimating this year's yield and price). The difference of $2.5 million was used to estimate the economic impacts of the expansion of crambe production on the North Dakota study area (table 3). 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. 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 on to 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 1

Economic characteristics of North Dakota study region

Nearly 24 percent of all jobs in the 15-county North Dakota study region are in the services sector

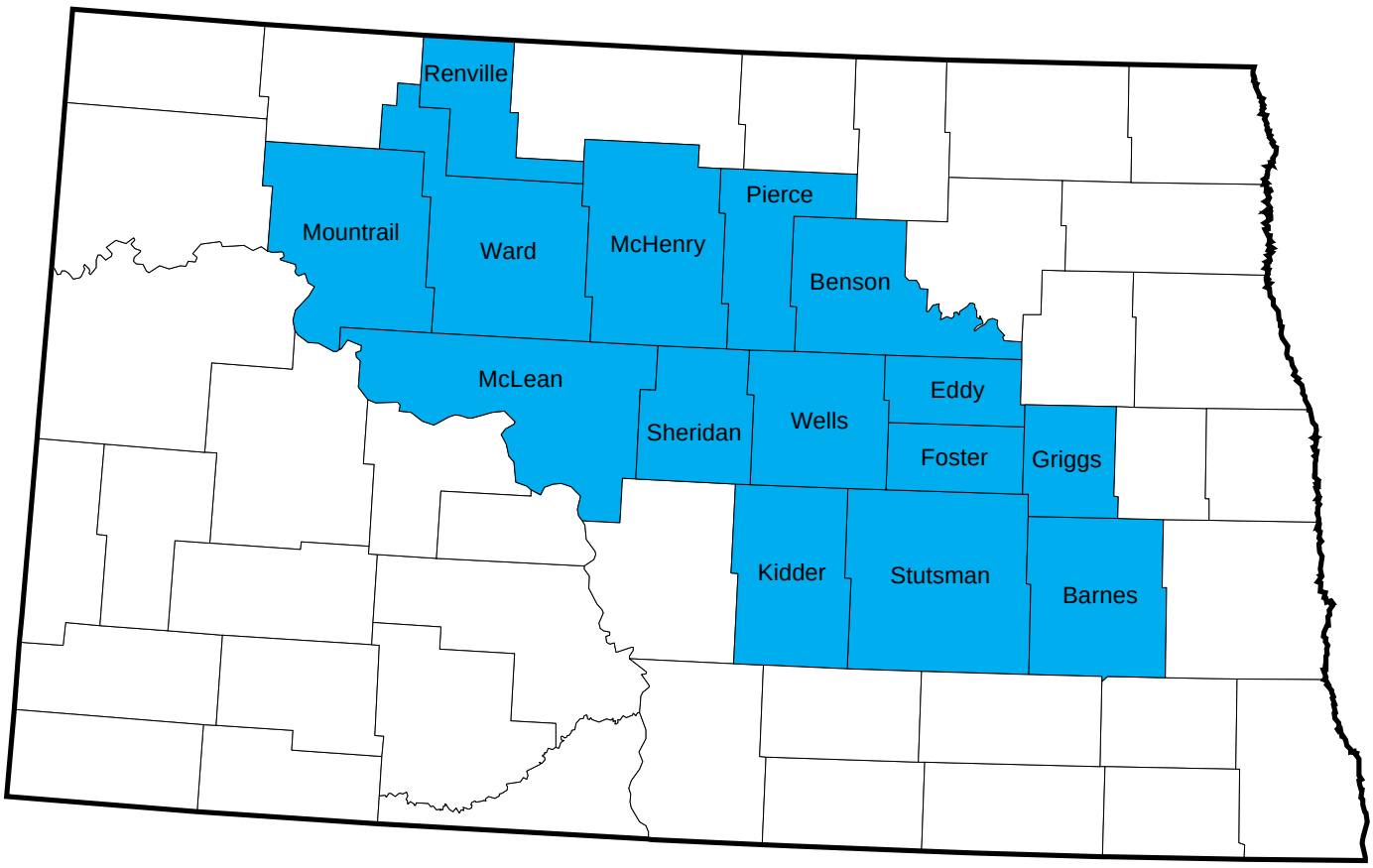
Item	Number
Population	149,700
Income per household (dollars)[1]	40,382
Total employment:	86,538
Agriculture	12,893
Mining	446
Construction	4,287
Manufacturing	3,414
Transportation, communication, and public utilities	4,048
Trade	17,929
Finance, insurance, and real estate	3,822
Services	20,741
Government services	18,636

[1]Includes noncash benefits.
Source: Minnesota IMPLAN Group.

Figure 1

North Dakota study region

Most of the crambe production is concentrated in this 15-county region



Source: Economic Research Service, USDA.

What is Input-Output Analysis?

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 in Foster County, North Dakota. 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 they are spent in the North Dakota study region.

The input-output model used in this analysis is called IMPLAN (Input-Output Model for Planning and Analysis). The 1993 IMPLAN Pro version was used to estimate economic impacts in this report. The model provides for county-level analysis from 528 industry sectors, similar in detail to the 3-digit SIC level 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.

Using the $2.5-million figure implicitly assumes that the planting of crambe on 28,000 additional acres in 1997 was on unproductive land, which may overestimate crambe's value to the North Dakota study region by not accounting for the opportunity costs associated with growing crambe. However, the per-acre return from crambe production of $83.04 far exceeds that of other crops grown in the region (table 4). By comparison, an increase in canola production by 28,000 acres would generate only $1.8 million in additional sales, $900,000 in total value-added, and 24 jobs, including induced and indirect effects. These impacts from canola are roughly half the size of those from

Table 2
Agriculture of the North Dakota study region
The study region produces over 26 percent of U.S. sunflower seeds

Item	Regional value	Share of national total
	1,000 acres	Percent
Acreage:		
Land in farms	11,462	1.2
Total cropland	8,837	2.0
Harvested cropland	6,062	2.1
Irrigated land	37	0.1
	$1,000	
Value:		
Agricultural production	715,074	0.4
Crops sold	523,719	0.7
Livestock sold	191,326	0.2
	1,000 bushels	
Production:		
Barley	43,259	10.9
Corn	2,739	**
Wheat	126,631	5.7
Oats	10,676	4.3
	1,000 tons	
Hay	992	0.8
	1,000 pounds	
Sunflower	589,288	26.3

**=Less than 0.1 percent.
Source: 1992 Census of Agriculture.

crambe production (table 3). Therefore, the *net* gain from crambe in this case may be viewed as the difference between the region's impact from increased crambe production and the region's impact from increased production of canola, the next best alternative crop. The difference would be even greater if crambe were substituted for crops less profitable than canola. Aside from the outstanding profitability of crambe, the grower also benefits by having another crop to put into the crop rotation, a benefit that is not captured in this analysis.

A similar impact analysis was performed on the oilseed processing plant (table 5). Of the $8 million outlay for the plant, $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. Because building the plant is a one-time shock to the region, these effects are not expected to be permanent.

The last phase of the crambe analysis is to examine the impacts associated with the oilseed crushing plant (table 6). 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. Direct sales are estimated at $7.4 million (see box "Estimating the Value of Crambe Production and Processing"). Including indirect and induced effects, the total value-added from crambe processing is estimated at $2.2 million, with a possible increase of 40 new jobs.

The combined direct effect from crambe production, the construction of the processing plant, and the crushing of

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 estimate the size of the crop, its value to the growers, and the value of the processed oil and meal. First, assume that 90 percent of the 50,000 contracted acres in 1997 will be harvested, that is, a 10-percent loss due to hazardous weather conditions, 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 hundredweight, the value of the crambe crop is estimated to be $6.136 million.

To estimate the value of production at the processing plant, industry sources suggest an 82.6-percent recovery rate for crambe oil and a 98-percent recovery rate for the meal at a mechanical processing plant. Crambe seeds contain 35-percent oil; therefore, there are 21.26 million pounds of oil in 60.75 million pounds of crambe. However, only an estimated 82.6 percent, or 17.56 million pounds of oil, is recovered. Subtracting the pounds of extracted oil from the total amount of crambe yields 43.19 million pounds of crambe meal. Using the estimated 98 percent recovery rate, the output of crambe meal is about 42.32 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 of supply and demand of crambe and industrial rapeseed. Crambe oil competes with industrial (high-erucic acid) rapeseed oil in national and international markets. If supplies are adequate, prices may be in the low end of the range. However, if supplies tighten, prices may rise to the upper end of the range. The price of crambe meal is probably about one-third the price of soybean meal. Crambe meal can be fed only in limited quantities to beef cattle, per FDA regulation, and feed formulators may not be familiar with it, but the residual oil in meal gives it a higher value than it would from solvent extraction. Given the volumes cited above, the value of the crambe oil is estimated at $4.9 to $6.1 million and the meal at $1.6 to $2.1 million. The total value of the two products is $6.5 to $8.3 million.

Table 3

Economic impacts of expanded crambe and canola production, 1997-98

The 28,000 gain in acres planted of crambe translates into a value-added increase of $1.8 million to the region

Impacts	Crambe production			Canola production		
	Sales	Value added	Number of jobs	Sales	Value added	Number of jobs
	- - - - -Million dollars- - - - -			- - - - -Million dollars- - - - -		
Direct	2.5	1.2	29	1.2	0.6	14
Indirect and induced	1.1	0.6	19	0.6	0.3	10
Total	3.6	1.8	48	1.8	0.9	24

Source: Generated by USDA's Economic Research Service using IMPLAN-Pro.

Table 4

Profitability of selected crops in North Central North Dakota

Crambe exceeds all other major crops in North Central North Dakota in profitability

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: North Dakota State University Extension Service, 1997.

Table 5

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

Although the impacts from the plant construction will be temporary, the region will gain $3 million in value added

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

Source: Generated by USDA's Economic Research Service using IMPLAN-Pro.

Table 6

Economic impacts of new plant operation, 1997-98

During the first year of operation, the new oilseed crushing plant will be responsible for the creation of 35 to 45 new jobs

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

Source: Generated by USDA's Economic Research Service using IMPLAN-Pro.

Table 7

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

Nearly $7 million in value added will be generated by the expansion of crambe production, oilseed crushing plant construction, and the sale of the crambe oil and meal in 1997

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

Source: Generated by USDA's Economic Research Service using IMPLAN-Pro.

Table 8
Combined employment impacts of crambe enterprises, 1997-98
Most of the new jobs created are in agriculture

Category	Direct job impact	Share of job created	Indirect and induced job impact	Share of job created	Total job impact	Share of job created
	Number	Percent	Number	Percent	Number	Percent
Agriculture	29	33	3	4	32	18
Mining	0	0	0	0	0	0
Construction	36	41	2	2	38	22
Manufacturing	13	15	3	4	16	9
TCPU[1]	0	0	8	9	8	5
Trade	0	0	30	35	30	17
FIRE[2]	0	0	9	10	9	5
Services	10	11	30	36	41	24
Government services	0	0	1	0	0	0
Total	88	100	86	100	174	100

[1]Transportation, communications, and public utilities.
[2]Finance, insurance, and real estate.
Source: Generated by USDA's Economic Research Service using IMPLAN-Pro.

the 1997 crambe crop is estimated at $17.9 million and 88 new jobs in the North Dakota study region (table 7). Indirect and induced effects bring the total to nearly $23 million in total output and 174 new jobs.

Job gains are disaggregated into nine major economic sectors (table 8). Direct job impacts occur in the agriculture, construction, manufacturing, and services sectors. Indirect and induced effects allow for 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 hospitals accounted for most of the new service jobs. Of total jobs created, 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 production will be able to supply market clearing levels of crambe oil. In addition to the employment and income growth estimated in this study, expansion of the processing plant in Foster County is anticipated. Once the plant reaches full-scale operation, employment in this higher valued industry will likely increase.

Conclusion

The development of new industrial crops may result in modest rural employment growth in agriculturally related industries. Choosing new crops that can attract related industries to a region, such as oilseed crushing, is key to using agro-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 this 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 related industries and in other industries as the new workers spend their wages.

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

For Further Reading . . .

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