

FSEP Grain Processing Literature Review
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Promising Product Lines From Regional Corn

As this literature review highlights, there are a lot of products that can be made from grain. Not all grain products fit into Michigan's economy however, the following are interesting opportunities that may fit into the regional agri-food system of Wayne, Washtenaw, Jackson, Lenawee, and Monroe counties:

- Bio-degradable plastics
- Corn oil
- Pet food/Supplies
- Latin American food products
- Cereal bars
- Solid fuels
- Biodiesel
- Expanded organic production
- Artisan bread

Grain Production In Southeast Michigan

Southeast Michigan includes several expanding urban centers and substantial agricultural production regions. Looking at the five-county region of FSEP (Wayne, Washtenaw, Jackson, Lenawee, and Monroe), there are more than 645,000 acres (1,007 square miles) used annually for grain production. (Michigan Agricultural Statistics, 2004). FSEP counties annually produce more than 25 million bushels of corn, 10 million bushels of soybeans, and 4 million bushels of wheat.

Where Is Michigan Grain Used?

As a state, Michigan produces 250 million bushels of corn annually. Half of

this corn is exported to Canadian processors that convert the grain into corn sweeteners, ethanol, and other commodity products.



Another major use for Michigan corn is the production of poultry feed in southeastern and eastern states. Major poultry producers purchasing Michigan corn include Tyson Foods, Perdue Farms, and Murphy Farms. Like corn, most Michigan soybeans are exported out of the state. Shipments to the southeast are purchased by Cargill for export or processing. ADM is also a major processor of Michigan soybeans. ADM processing facilities are located in Ontario, Canada. Most Michigan wheat is processed here in the state. Major users include Star of the West, Mennel, and Jiffy. Major out-of-state users of soft red winter wheat include White Lilly Foods in Tennessee. (Information on grain utilization provided by Ken Lake, Michigan Agricultural Commodities, 2006).

Is There Regional Opportunity For Economic Growth In Grain Processing?

There are economic variables that affect the location of grain processing facilities. Obvious factors include access

to grain producing farms, costs of labor, land, utilities, and access to required infrastructure. However, information describing an ongoing analysis of economic variables as they apply to the feasibility of expanded grain processing in Michigan is not easy to find.

Demand for grain products and co-products changes over time. An example of this type of change is ethanol for use as fuel in internal combustion engines. Current commercial ethanol production is often described as originating out of Minnesota. In the 1970's demand for the fuel was limited and the potential for locating production facilities in Michigan or Ohio was low. Now, in 2006 there is a production facility in Caro, Michigan and four other Michigan production facilities in some phase of the launch process. At least five groups are working toward launching new ethanol production ventures in Ohio. The point being made is that regional leaders need to cycle through consideration of grain processing entrepreneurship. Projects that are not feasible today can become feasible with changes in trade policies or supply/demand relationships.

Changes in technology also affect the potential for grain processing enterprises. As little as a decade ago most corn-derived consumer products came from wet milling facilities. Wet mills require large capital outlays and high corn utilization rates. This makes wet milling unfeasible in Michigan's agricultural economy. Recent changes in corn processing technology have made it possible to extract a broader range of industrial and consumer products from dry mills, which are better suited to our region.

In addition to large scale processing facilities, like ethanol plants which commonly use 18 to 20 million bushels each on an annual basis, there are other grain processing ventures that require moderate and small quantities of grain.

Introduction To This Literature Review

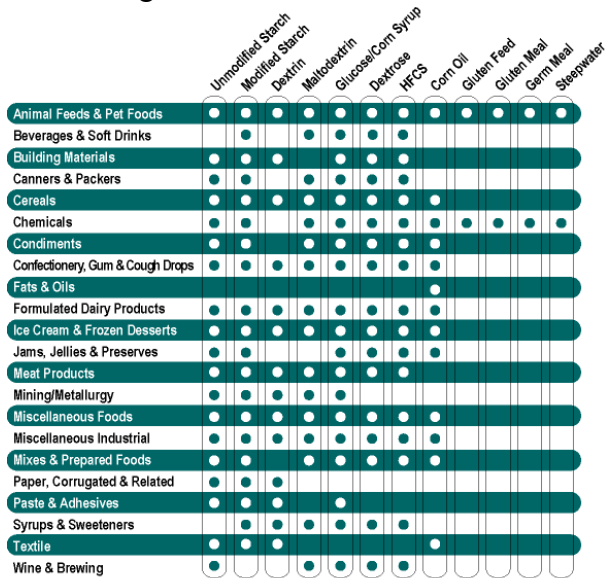
This literature review is largely web-based, and focuses on grain processing ventures and enterprises. Results of this review are available to entrepreneurs interested in increasing local or regional grain processing in southeast Michigan. This review is not exhaustive. FSEP leadership team members will continue collecting information as part of an ongoing plan of work. More detailed papers will be written, focused on the most promising venture areas for communities in the FSEP region. FSEP will work with the MSU Product Center to develop boiler plate business plans for promising venture areas that can be expanded by entrepreneurs interested in launching agri-food ventures benefiting the FSEP region.

Corn Products

Corn is used to manufacture consumer products or product components in a wide array of economic sectors. The North American Millers' Association lists 21 food products derived from corn dry milling, 12 industrial products, and three categories of pet food products (www.namamillers.org/prd_c_prd.html). The NAMA reports that dry milling product utilization is broken down as follows:

Animal Feed	31 percent
Brewing	23 percent
Breakfast Cereal	22 percent
Other Food	16 percent
Industrial	8 percent

The following chart illustrates corn product sectors and the grain components used in production of consumer goods.



The Corn Refiners Association recounts the history of product extraction from corn. Looking at the chart above, it is interesting to ponder the fact that the only extracted product from corn in the earliest stages of processing history (1844) was corn starch. This is interesting because knowing this history helps us understand how continued innovation can strengthen farm businesses and the processing industries that affect supply/demand for grain commodities.

(<http://www.corn.org/web/history.htm>)

Corn Processing

The two major approaches to processing corn are wet and dry milling. The corn wet milling process separates corn into its four basic components: starch, germ, fiber and protein. Starch, glucose, and dextrose are core products of the wet milling process. Wet milling also is the primary method for extracting corn oil, germ, gluten, syrup, and alcoholic

beverages. A primer on wet milling can be found at the following web site:

<http://www.bio-link.org/pdf/corn7.pdf#search='corn%20wet%20milling%2C%20lab'>

The wet milling process soaks corn in sulfur dioxide for 24 to 36 hours so the kernel can be separated into its four component parts--germ, protein, fiber and starch. The starch is fermented into ethanol, and the three remaining parts are sold as high value co-products.

Dry grind, on the other hand, starts with raw corn, finely milled and cooked. The starch is fermented and converted into ethanol, and the three non-fermentables are carried through the process and recovered at the back end as a feed product. The average wet mill operates at 200,000 bushels a day, while the average dry grind plant operates at 50,000 bushels a day. (University of Illinois, <http://www.aces.uiuc.edu/news/stories/news1990.html>)

The cost of building a wet mill, along with the required volume of grain flow are reasons cited in explaining why wet mills will not be located in Michigan. In discussions about locating a dry mill for ethanol production in Riga, Michigan, Brian and Brian Inc., a leading consultant on expansion of the ethanol industry, explained that large scale corn processing ventures cannot consume more than 25% of regional corn supply without driving local grain prices to cost prohibitive levels.

Quick Germ/Quick Fiber Processing

Expanded industrial corn processing in Michigan will more likely be related to intense processing of distillers grains from regional dry mills designed for

ethanol production, or to development of niche market products. An article out of University of Illinois describes quick germ and quick fiber processes that broaden dry mill co-products. This new approach to processing yields corn germ and fiber for development of higher value consumer goods. It also increases the protein content of distillers grain used for livestock feed.

(<http://www.aces.uiuc.edu/news/stories/news1990.html>)

The quick germ and quick fiber process are presented in the form of a power point presentation on file in the Washtenaw MSUE office.

Sun Source Bioenergy LLC has developed a process for extracting corn oil during the dry milling process. http://www.greencarcongress.com/2005/06/new_revenue_str.html. Extracting oil increases the ease of handling distillers' grain and allows ethanol producers to diversify their product line by converting corn oil into diesel fuel.

Higher-Value Corn Products

Zein

Zein is a resin product extracted from corn through dry milling. It is one of the main corn proteins. The major market for zein is biodegradable plastics. Zein manufacturing involves using ethanol to extract zein from distiller's grain. Following are four paragraphs from a University of Illinois research proposal describing plans for zein process development:

The co-products of the corn processing industry have generally been regarded as commodities to be disposed of at whatever price the market would bear. However, continued

increase in demand for starch-based products (e.g. sweeteners, ethanol) require the simultaneous development of new uses for the non-starch co-products, in order for corn refiners (especially dry millers) to maintain their viability. One such product with considerable promise is biodegradable plastic films and packaging that are based on corn protein (zein) and *not* based on starch. Such a product was recently developed by Dr. Graciela Padua and co-workers at the University of Illinois. To make that product and other zein-based products a commercial reality, it is critical that cheaper methods of producing zein be developed.

Protein forms about 10% of the dry weight of corn. It is composed mainly of zein (a highly hydrophobic protein, soluble in isopropanol or ethanol) and glutelin (soluble in aqueous alkaline solutions). Zein comprises about 50% of the endosperm protein (41% of total kernal protein) on a dry basis. High-purity zein (often combined with vegetable oils and glycerin as plasticizers) is used as a waxing or glaze, to enhance shelf life of pharmaceutical tablets, nuts and candies by acting as a water and oxygen barrier. Zein has been produced industrially since at least the 1950s, but many of the large plants are not in production today. As far as we know, there is only one small producer of zein in the U.S. today (Freeman Industries, Tuckahoe, NY). Their cost of zein approaches \$5-9 per lb. depending on the grade and purity. However, this price makes zein an uneconomical raw material for plastics where polymer resins sell for \$0.20-0.35 per lb. Even assuming that a "biodegradable" film or packaging can command a higher market value, the cost of zein (as a resin) should not exceed \$1 per lb.

The potential market for zein should now be good, considering: (1) The low margins in some sectors of the corn processing industry, eager to find higher-value products, (2) Valuable lessons learned from previous attempts at corn-based "biodegradable" plastics: these were largely starch-based and did not fare well in the market for various reasons, and (3) Increased demand for true 100% biodegradable packaging and films, primarily from the fast food industry, but slowly filtering down to the entire manufacturing sector that uses packaging of any kind. A manufacturer of packaging materials estimated the potential market for zein-based plastics as "billions of pounds per year" if the cost could be brought down to reasonable levels (Joachim Wenderhold, Executive Vice President, White Cap, a division of Continental Can Europe. Personal communication October 1, 1996). Since this market is presently focused mainly in Europe, successful implementation of our COPE process by corn processors should simultaneously improve their bottom line, increase the demand for corn and stabilize the local farm economy, while improving our export market and balance of payments.

If zein-based biodegradable films and packaging were to capture even a minor share of the packaging and films market, it could conceivably use up all of the zein in the 2 billion bushels presently used by industry. However, this is possible only if the cost of zein approaches that of the major synthetic plastics, e.g., polyethylene and other polymer resins. These can be obtained for \$0.20-0.35 per lb. by film and packaging manufacturers. Assuming there is an additional value because of the biodegradability of a zein-based

plastic, then zein must be available on the world market for \$0.60-1.00 per lb. To get a reasonable return on investment, zein must be manufactured by a corn processor for \$0.40-0.70 per lb. If DDGS is used as the raw material for our COPE process, and it can fetch \$0.09 per lb. as animal feed, then it provides a small but significant window of opportunity to meet the zein-based film and packaging market, if a low-cost method of extracting zein can be developed. This is the goal of our research project. (<http://www.ilcorn.org/Research/97011201research/97011201research.html>)

With expanded dry milling capacity in the Great Lakes region surrounding FSEP, this intense mining of distillers grain merits exploration. Great Lakes Ethanol LLC has expressed interest in this type of processing innovation.

In addition to zein, researchers hope to develop economical methods for producing organic acids, amino acids, vitamins, and food gums. Citric and lactic acids can be found in hundreds of food and industrial products. Lysine, threonine, and tryptophan are amino acids that have value as feed supplements in livestock industries. Vitamin C and E can be extracted during corn distillation. In addition to zein-based plastics, packaging peanuts are being made by modification of lactic acid.

Starch

While corn starch is a valuable component of corn with diverse product applications, the region's commitment to converting corn starch into ethanol lowers the probability that new large-scale starch-based business enterprises or ventures will develop within the five-

county FSEP region. It may be possible to develop higher-value niche products that can be manufactured to consumers seeking starch-based products made using local corn. Product lines include paper, textiles, surface coating and adhesive applications, and drilling mud used in oil exploration. Corn starch is used in industry as flocculating agents (coagulants), anti-caking agents, dusting powders, and thickening agents. Corn starch is used in processed foods to maintain proper textural characteristics during freezing, thawing, and heating. Starch is the necessary ingredient in instant pie fillings and puddings.

New discussions on the bio-economy may influence industry commitments to using starch for ethanol production. Discussions on a bio-economy center around the concept of replacing petroleum products with plant-based manufacturing inputs. As petroleum supplies dwindle or become less reliable the incentives for converting starch into a broader array of consumer products may result in re-design of ethanol mills. This assumption is supported in a report from the U.S. Department of Energy (www.eurekaalert.org/features/doe/2003-05/dnnl-fcf052903.php)

Pet Food

It is common knowledge that corn is a significant ingredient in many pet foods. Iams Pet Food posts information on their web page explaining why they include corn as an ingredient in dog food. They write:

It is more appropriate to associate the corn used in our products with "corn bread" rather than "corn on the cob." The difference is similar to cooked corn versus raw corn. Only the highest-

quality corn is used in our products. The corn is finely ground to a meal, which breaks up the outside covering of each kernel, and then it is cooked, which increases its digestibility.

Corn grits and corn meal are used in our foods as high-quality sources of carbohydrates. Carbohydrates are an important source of energy.

http://iams.com/en_US/jhtmls/nutrition/sw_NutritionQuestions_answer.jhtml?speciescode=D&brandcode=I&localeid=en_US&pagetypeid=PN&questionid=360#Q2

Pet food is sold in most grocery stores, pet supply stores, and many hardware stores throughout the FSEP region. In the course of this review we could not identify pet food manufacturers in the five county area. Given the supply of grain and meat processing co-products in the region this may be an economic sector that can be expanded.

Latin American Product Lines

In addition to the substantial and growing Hispanic population in southeast Michigan, recipes for food from Latin American countries is becoming increasingly popular. Corn is the essential ingredient for making tortillas, tamales, hominy, and pozole. An article posted at www.gourmetsleuth.com/masanixtamal.htm describes several specialty corn products including food goods and craft materials. The article describes small scale processing of corn.

Hispanic minorities are projected to surpass African American populations by 2010. Mexicans are the largest Hispanic subset, making up 59% of this sector. Eight percent of full service

restaurants offer Mexican food as their principal menu type. Tortilla chips account for 47% of Mexican food sales, followed by tortilla and taco kits (26%), and salsa (15%). (Mintel, http://reports.mintel.com/sinatra/reports/search_results/show&&type=RCItem&page=0&noaccess_page=0/display/id=2173/display/id=48430)

A case study in southeast Michigan just outside of the FSEP region illustrates the potential for introducing Mexican food products.

<http://www.detnews.com/apps/pbcs.dll/article?AID=/20060214/METRO/602140358/1001>

The salsa developed by a Ferndale restaurant taps into a popular ethnic food market segment. They do not mention in the description of their business any commitment to using local products in salsa production. Ongoing research on potential for expanded grain processing in the FSEP region will attempt to document the degree to which consumers of corn chips and other masa products will give preference to locally grown ingredients. Any new business in this sector will be competing against heavy hitters like Frito-Lay, Pillsbury, and Kraft Food. Mintel reports indicate that 93% of Mexican food sales take place through grocery stores.

Consumers prefer tortillas made from white corn types. White corn has a harder kernel. It comprises 20% of the U.S. crop. An article on small scale tortilla production can be found at <http://www.ianr.unl.edu/testard/rn/0399/tortilla.html>.

Corn Cereal Bars

The MSU Product Center worked in collaboration with the Hale Group to

define opportunities for product development from several agricultural commodities. One of the product profiles they evaluated is corn cereal breakfast bars. In summary statements they report few opportunities for bars that appeal to the demand driver of value, selective opportunities for bars that appeal to the demand driver of convenience and ethnicity, and many opportunities related to the demand drivers of indulgence and wellness.

Sixty-nine percent of households with children purchase cereal breakfast bars. Value oriented firms need to produce in large volumes to capture economies of scale. Minority communities with higher average population growth present an interesting market for niche product development. Entrepreneurs will benefit from careful product development that accounts for minority community taste or flavor preferences. Careful product placement in stores that are frequented by minority consumers will affect product sales targeting ethnic groups. Consumer interest in wellness can be responded to through development of whole grain, vitamin fortified cereal bars. Production of bars with unique, desirable flavors could trigger indulgence spending within several population sectors.

The report on cereal bar product development cautions that this product sector is relatively mature with 1,952 product introductions throughout the world in 2006. Shelf space is scarce, and retailers are developing their own product lines/labels. Still, there are major food retail businesses, including restaurants, which have not given thought to branded product development. Entrepreneurs may find

willing partners within the retail community if product development is well researched and data can be presented to illustrate a strong connection between new product and growing consumer segments.
<http://www.aec.msu.edu/product/roa.htm>

Oil

There was earlier mention of more intense processing of distillers grain to extract oil. That discussion focused on industrial use of this oil for diesel fuel production. The MSU Product Center/Hale Group reports suggest that there are opportunities for developing corn oil food products.

This is a difficult sector to penetrate with new product. Ninety-three percent of households use cooking and salad oils. Oils low in cholesterol, fats, and other negative attributes can gain market share. Combining attributes such as wellness and convenience will enhance product appeal. They also mention potential for products that can establish unique flavor, or products that are marketed through channels that reach underserved ethnic populations.

Approximately 99 percent of all retail sales are through supermarkets. The market is mature, and dominated by large firms.

Snacks

The market for tortilla chips continues to expand. The market for corn chips is stagnant (MSU Product Center/Hale Group). Most consumer products are made from yellow and white corn. Some blue corn varieties are available. There may be room for specialty products considered to be gourmet, health food, or well targeted toward ethnic

communities. Unusual flavoring has been an angle major players have been pursuing. Advice in product development within this sector is to work toward becoming the low-cost producer.

Paste

A small, seemingly incidental use of corn or wheat is production of paste (ie: wall paper paste). The website, www.care2.com/channels/solutions/home/9 provides a simple recipe using flour, alum, water, and oil of cloves.

Fuel

The recent peaked interest in renewable fuels includes consideration of grain and other agricultural products as a fuel for industrial and residential purposes. The Agricultural Utilization Research Institute posts a report at <http://www.auri.org/research/fuels/pdfs/fuels.pdf#search='auri%20fuels%20initiative'>

The report lists various agricultural fuel sources and provides information on BTU/lb, ash, and sulfur emission. Corn variations for fuel include corn gluten feed, shelled corn, high-oil corn, waxy corn, corn cob, corn stover, and dried distillers grain. These corn fuels produce approximately 8,000 BTU per pound.

As noted in this report, the economics of using agricultural fuels must account for costs of traditional fuels, transportation, and physical processing of agricultural commodities.

Dr. Chris Schilling of Saginaw Valley State University has researched use of corn as an alternative to petroleum based fuels. A copy of notes from Dr. Schilling's presentation to the Michigan

Corn Grower's annual meeting is on file in the Washtenaw MSUE office. His presentation highlights existing institutional use of corn to heat/air condition buildings, greenhouses, and to generate warm water for recreational facilities.

Industrial Components

An article posted at www.eurekaalert.org/features/doe/2003-05/dnnl-fcf052903.php describes efforts to intensify corn processing to extract several industrial components from corn fiber. Corn fiber is fractionated into its primary components of carbohydrates, oil, and protein. Carbohydrates yield five and six carbon sugars (glucose, xylose, and arabinose). The glucose is used to make fuel ethanol. Other sugars can be converted to propylene glycol and ethylene glycol, chemicals that are used in production of plastics, polyesters, and antifreeze. Corn oil is a source of phytosterols, a high value product used in nutraceutical food supplements and as "botanical oils" used in personal care products.

The residual product of more intense component extraction is still suitable for livestock feed. The protein content relative to traditional distillers' grain is doubled. The product is also less bulky, reducing transportation costs by 50%.

This corn fractionation process is described at www.arserrc.gov/ccse/BiofuelsandBiobasedProd.htm

An article from the Missouri Value Added Center reports that in 2001 an estimated 80,000 tons of corn fiber oil were forfeited to less efficient corn processing systems. With expanded dry

milling of corn for ethanol production this figure has increased. Corn oil fiber is different from oil derived from corn germ. It is higher in phytosterol that offers antioxidant properties in addition to lowering cholesterol. (<http://valueadded.missouri.edu/news/rt353.asp>)

A report from University of Florida Extension explains how polylactic acid (PLA) from corn and wheat can be processed into a recyclable, affordable plastic that can replace petroleum-based products.

(http://edis.ifas.ufl.edu/BODY_AE210)

PLA compares well with other popular plastics already used for packaging. It is clear, biodegradable, naturally glossy, and can be used in production of batteries, toys and other consumer products. It is resistant to moisture and grease. It has flavor and odor barrier characteristics, making it suitable for packaging of foods and soft drinks. It has comparable tensile strength and elasticity relative to petroleum based plastics used by industries in the 20th century.

PLA manufacturing involves use of dextrose derived from corn milling. Unrefined dextrose is processed from the starch. Dextrose is turned into lactic acid using fermentation. The chemical process for converting lactic acid is described in this University of Florida article. It is also described in an Agricultural Research Service article at www.ars.usda.gov/research/projects/projects.htm?accn_no=408060

Horticultural uses of PLA include bedding plant containers, flats, and pots for producing merchandising plants.

PLA is also used to cover greenhouses, to make plastic mulch for weed control, and for making foams for cut flower display.

(<http://agproducts.unl.edu/plahort.htm>)

What About Wheat?

As mentioned earlier, most Michigan wheat is processed in-state. FSEP leaders are working to develop business expansion and new ventures that result in net economic gain for the state's agricultural economy. This means that more careful analysis is needed for wheat initiatives.

Kinds Of Wheat

There are at least nine kinds of wheat including Einkorn, Emmer, Spelt, Durum, and Common wheat. There are also several grades of wheat: hard red, durum grade, hard red winter, soft red winter, and white wheat.

Soft Red Winter Wheat

Michigan farmers raise soft red winter wheat. There are regions within the state where white wheat is raised. Jiffy Mix, a wheat miller located in Chelsea, Michigan, processes white wheat into flours for baked goods. But white wheat is prone to sprouting in the field just prior to harvest.

Soft red winter wheat accounts for about 30 percent of the U.S. wheat crop. It is the principal wheat grown east of the Mississippi River. It is well adapted to humid climates. This wheat is relatively high in starch. The grain is used for pastry, cake, breakfast foods, and home baking.

In recent years there have been prolonged periods during which winter wheat production was unprofitable for

farmers in southeast Michigan. This situation was brought about by factors in the regional and national wheat brokerage systems. Beginning in the year 2000 this problem was corrected. Now farmers raising wheat on good soils under progressive management systems are combining stronger prices with good yields to generate net income.

In addition to producing a marketable grain, wheat producers can harvest straw. The straw has a market of its own for livestock bedding, erosion control and seed protection in landscaping, and development of industrial products. In other states wheat has been used in ethanol production. Many of the industrial products derived from corn can be made from wheat and other common grains.

Wheat Milling

Wheat is milled using a roller process. Grain is cleaned and scoured. All foreign seed, dust, sticks, straw, and pieces of bran are removed. Next, wheat is tempered. A little water is added to toughen the bran. Conditioned and tempered wheat is broken, ground, and rolled several times, with different grades of flour being collected with each grind. The finest flour is "first patent" flour. This is considered to be the best grade. Material that has been separated out in earlier grinds is referred to as middlings. Middlings are processed into inferior grades of flour, or used for other purposes. Granular particles midway in size between the grain and flour are known as semolinas. Semolinas are used to make hot instant cereal known as farina.

Wheat Entrepreneurship

An article written by AATRA

(www.attra.ncat.org) features wheat farmers who have tried to capture a higher share of the total value of wheat through on-farm processing. The article describes a Kansas farm business that started, then expanded on small scale production of whole wheat flour. For novices in wheat flour production, an important piece of advice is given that will determine potential for market expansion and repeat customers: experiment with varieties or blend of varieties to develop a flour that meets consumer needs. Different wheat varieties have different milling and baking characteristics. An entrepreneur must develop a blend that consistently satisfies end users.

Wheat millers need to comply with health department regulations; develop equipment for milling that matches their level of production; use certified scales suitable for retail business; and develop a written business plan that accurately describes the purpose of the business and how it will succeed in fitting products into the marketplace.

Markets for organic food products have been expanding over the past decade. Organic crops tend to receive production premiums in the marketplace however, farmers tapping into organic markets have to have a destination in mind when seed is planted. Cost of delivering organic wheat to a buyer offering premiums may be higher than costs for conventional grain because the infrastructure for organic grain is relatively limited.

The AATRA publication discusses the opportunity for producing organic wheat for the organic livestock industry. Freshness is a primary concern. Once

grain is ground it begins to oxidize. Also, state regulations require labeling. You have to tell the department of agriculture in each state where product is sold exactly what's in the feed in terms of protein, fat, fiber, etc. This means that the volume of product needs to be high enough to allow recovery of laboratory analysis and label development.

Wheat Products

There is a detailed report by Sparks Companies outlining new and improved wheat uses (2002)

(<http://www.wheatworld.org/pdf/NAWG%20New%20Improved%20Uses%20Report%20Final.pdf#search='wheat%2C%20uses'>).

The following table from the report presents data on products, years to commercialization, added value to grain producers, and potential demand volumes:

	Years Until Commercialization	Premium Potential	Volume Mil. Bu. Equivalent
New or Improved Uses			
Wheat Beer	1	36	4
Biodegradable Plastic	5	0	30
Wheat starch blasting	1	0	1
Wheat cat litter	2	4	6
Cosmetics	2	0	9
Ethanol	1	0	50
Aquaculture/Turkey feed	1	0	30
Meat substitutes	1	0	20
New or Improved Characteristics			
Antioxidants	9	200	70
Hard white wheat	3	8	300
High molecular weight glutenin	9	26	300
Low carbohydrate	8	200	80
Nonallergenic (Initial)	5	30	5
Nonallergenic (Long Term)	10	0	2300

Organic	1	100	40
Waxy wheat	4	15	70
New Uses-Wheat By-Products			
Wheat straw composites	6	38	90
Ethanol from staw	9	38	300
Straw plastic fiber	4	38	20

Brief Comments On Select Wheat Products From Sparks Report

Wheat Beer

If entrepreneurs take a run at capturing part of the beer market they will have to overcome some technical barriers to brewing wheat. The impact on local or regional wheat marketing would be minimal because of the low volume of wheat needed to produce beer products.

Biodegradable Plastics

As mentioned in the section on zein products, biodegradable plastics are of interest in the broader economy but the cost of materials is relatively high compared to petroleum-based products. There have also been performance trait concerns with bio-plastics. They have had problems with swelling, deformation, and cold weather brittleness. Wheat-based bio-plastic has performed better than PLA, withstanding hot foods better and degrading more fully than corn products.

Cat Litter

Cat and animal litter materials account for more than \$1 billion annually in the U.S. economy.

Traditional clay-based litters have been known to cause respiratory problems in cats and other pets. Clay-based products do not decompose in landfills, and are not designed to flush into sewer systems.

Wheat products overcome these negative traits. They also contain an enzyme that absorbs ammonia odor. They also clump rapidly, offering an advantage over corn and other plant-based litter products.

Meat Substitutes

Major investments by Kellogg and Kraft in meat substitute product lines signals a period of potential growth for grain-based food products. Even Burger King has developed a veggie burger. In 2001 Sparks reports that sales of meat substitute products reached \$194 million, an increase of 6.3% over the previous year.

Wheat products in this category offer the advantage of taste neutrality. Blending wheat with soy product allows entrepreneurs to manage taste while still claiming the hot market trend of soy health traits.

Given the prolonged price trough for commodity wheat, product development may be more feasible now than in past years. Wheat continues to be a strong part of regional crop rotations. It can be bought at relatively low prices.

Organic Wheat

Sparks reports that in 2000 there was around 140,000 acres of organic wheat production. With steady demand for organic food products, this acreage level could increase for several years. General Mills has introduced an organic breakfast cereal line. Projected exports of organic products to Europe are strong.

From FSEP's perspective the driving force behind local organic wheat production would be a strong local demand for product lines. We lack research results measuring producer and consumer interests in this opportunity.

Baked Goods

The MSU Product Center provides a good description of market opportunities for converting wheat into cookies, breads, crackers, and other baked goods for Michigan residents.
<http://www.aec.msu.edu/product/roa.htm>

There have been examples of cake and pastry products that have appealed to consumer interest in value and wellness. Sugar-free fruit pies and low-fat pound cakes illustrate this concept.

There have also been product introductions that account for measured differences among ethnic and demographic categories. Examples include trends of smaller households purchasing single-serve products, young single males tending to be snackers or impulse buyers, and African American households purchasing relatively high volumes of cake products. Ethnic groups with larger average family size tend to purchase more cookies and other sweet baked goods that appeal strongly to children. New and different flavors of crackers can be developed to appeal to ethnic group taste preferences.

Meeting consumer expectations for freshness in wheat-based product lines and baked goods opens the door to entrepreneurs who develop product lines for targeted market sectors in southeast Michigan.

There are selective opportunities for entrepreneurs interested in appealing to ethnic preference trends related to taste and texture of breakfast cereals.

An article posted by the Agricultural Research Service of USDA suggests that the soft red winter wheat can become a higher quality baking flour for breads and cracker production if plant breeding initiatives succeed in development of varieties with stronger gluten strength. (www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=129338)

Artisan Breads

There are Michigan companies that have succeeded in the artisan bread sector of the food economy. Artisan bread is best described by thinking about the person who makes the bread. "An artisan baker is a craftsman who is trained to the highest ability to mix, ferment, shape and bake a hand crafted loaf of bread. They understand the science behind the chemical reactions of the ingredients and know how to provide the best environment for the bread to develop". (www.artisanbakers.com/about_bread.htm.)

Artisan bakers in the Traverse City area have expressed interest in franchising their production systems and product lines. There are higher income communities in the FSEP region that may respond well to this type of conversion of commodity wheat into consumer goods.

Mintel reports recount the impact of low-carb diets on bread consumption. Recent reports indicate that low-carb product lines have run their course, and that consumers are returning to product

lines that captured shelf space before the Atkin's diet passed through.

Wheat Straw Product Lines

Several industrial and consumer products can be manufactured from wheat straw. Examples include plastics, particle board, ethanol, and solid fuels.

Whereas some reports indicate that wheat may be superior to corn in production of biodegradable plastics, wheat is currently viewed as a marginal material for production of particle board used in building construction. Wheat straw is relatively high in silica. This causes higher wear rates of tools. Also, glues used to create particle board do not result in end product that is durable under high-moisture conditions.

(www.westbioenergy.org/nov98/1198_01.htm).

Soybeans

Like corn, soybeans first came into the American economy with a modest outlook. A 1939 Agricultural Experiment Station bulletin from University of Illinois recounts how initial soybean introduction to American farming focused on varieties best suited to oil, industrial, or forage use.

(www.attra.ncat.org)

Today most soybean acreage is still planted to non-edible varieties, food grade soybean acreage has been rising. Michigan extension educators in north central regions have helped farmers increase acreage of organic food grade beans, bringing about improvements of farm profitability and expanding consumer interest in local farm goods.

Tofu, Miso, Natto, Edamame, and Tempeh are all examples of Asian food

product lines made from food grade varieties that have associated premiums for growers willing to focus more on net income than on yield and gross income. Soy milk is produced by American Soy, located in Washtenaw County. Other organic soy products are produced by Eden Foods, located in Lenawee County. Soy flour is reported to be an excellent source of protein, iron, calcium, and B-vitamins. Soy oil is extracted from whole soybeans. It is cholesterol-free, low in saturated fat, and contains no protein. Rosie's Roasters is a branded product from Washtenaw County. Tom and Rosanne Bloomer have developed several flavors of roasted soybeans marketed through regional grocery outlets as a high quality, nutritious snack food.

Production of food grade soybeans has received mixed responses from regional farmers. Farmers and local grain elevators are not prepared for the identity-preserved handling systems required to pursue this economic opportunity.

Non-Food Products

Non-food product development from soybeans was rather stunning during the 1980's and 90's. Product lines include body care products, candles, cleaners, composite materials, crayons, diesel additives, fabric conditioner, flooring, hair conditioners, hair styling aids, hand cleaners, pens, polish, shampoos, solvents, and furniture waxes.

One of the notable ventures into Michigan soybean processing is Thumb Oil Seed LLC. This company was initiated through MSUE in the Thumb area of Michigan. Originally farmers worked together to develop a motor oil

for use in automobiles. After the venture was launched and facilities were operating, need for increased profitability led to experimentation and development of food-grade product lines.

The broad array of soy products described at www.soyworld.com raise a puzzling question for those interested in our regional agri-food system: “Why haven’t we heard more about regional soybean processing ventures in Michigan”?

The MSU Product Center worked with regional entrepreneurs to explore the potential for regional production of biodiesel. Systems were evaluated for production of biodiesel from soybeans, as well as from waste cooking oils. Previous efforts have not yielded pro-forma budgets strong enough to justify investment. New efforts in 2006 look more promising.

Production of biodiesel is relatively simple. Basic materials and ingredients are readily available. Information on small scale production can be found at http://journeytoforever.org/biodiesel_mike.html



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