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ANIMAL FATS: PROPERTIES, SUPPLIES, MARKETS, AND RESEARCH[1]

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ABSTRACT

Animal-derived fats are a minor and declining portion of the total world production of fats and oils. Tallow and grease account for 10% of world production and butter oil 7%. The USA is overwhelmingly the largest producer and exporter of tallow. In its own market, edible tallow use for edible purposes has declined, and insignificant price differentials between edible and inedible grades have led to edible tallow's use in inedible markets. Tallow production is expected to expand in the USA and China, remain stagnant in Europe and continue its great decline in the former Eastern Bloc. Growth in tallow consumption is in animal feed, particularly for feedlot cattle, dairy cows and turkeys. U.S. feedlot operations produce cattle with high yields of rendered fat (50-55 kg/head). Although slaughter weight of hogs is up, the extra weight is meat, not fat. Poultry fat production typically disappears into poultry rations in that integrated industry. Export demand of tallow is expected to increase as developing countries increase their standard of living. New markets in Latin America will develop, particularly for the USA and Canada if the NAFTA umbrella is extended. GATT will facilitate trading, but with stricter requirements for

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uniformity and specificity on composition and properties. Tallow prices have risen, influenced by a doubling in the price for its chief competitor, palm oil. Regarding butter, the combined EU is the world's largest producer, followed by India, Russia and the USA, but the ranking for exports is topped by New Zealand, followed by the USA and the EU. Countries comprising the former Soviet Union are the largest group of butter importers. Since 1991, worldwide consumption of butter has declined 2% annually. Butter stocks and pricing have been influenced greatly by government price support and reserves. A temporary suspension of price support among the member countries of the IDA (including the EU, Australia and New Zealand, but not the USA and Canada), new agreements for export to the former Soviet Union, and a worldwide decline in acceptability of butter by the consumer (despite new anxieties over trans fatty acid content in margarine) all have influenced the pricing and depletion of worldwide stocks of stored butter. The greatest influence on that market, however, would be the substitution of % butterfat by % protein as the trading factor for milk. Production, consumption and trade statistics gathered from the USDA, GATT, and professional and trade groups will be documented. Research thrusts of potential impact on these commodities include biodiesel production -- which could lead to a major new market for tallow and grease -- and encapsulation of butterfat using starch or whey proteins -- which could revolutionize the preservation, storage and use of that commodity.

It is no surprise that most of the traded fats and oils are vegetable in origin. Animal fats, including tallow, grease, lard, poultry fat, butterfat and marine oils, together constitute 20% more or less of the world trade in fats and oils (Table 1) (1).

Table 1: World Production of Fats and Oils (thousands of metric tons, 1991/1992)

Animal Fat:	Butter (80% fat)	5320	7.3%
	Tallow and Grease	7030	9.6%
	Marine Oils	1110	1.5%
Vegetable Oils:	Soy	16890	23.2%
	Palm	11500	15.8%
	Other	31010	42.6%
Total:		72860	100.0%
	Total animal fat:	*13460*	*18.5%*
	Total vegetable oil:	*59401*	*81.5%*

This overview of animal fats will summarize fatty acid data for several classes of animal fats, review some statistical data on world trade in these materials, and discuss a few trends in the industry and some major research thrusts.

Tallows and greases are the rendered products from animal material. Beef fat is the primary source of tallow. Edible tallow comes directly from the food industry, and typically is lower in free fatty acid content than its inedible counterpart. A fat product must have a titre point, or solidification temperature, of 40°C or higher to be classified as tallow. Lower titre point products are classified as greases, with their main sources being lard and poultry fat (2).

1. FATTY ACID AND OTHER LIPID PROFILES

The fatty acid data presented in Table 2 are taken from extensive tabulations recorded in the USDA 1979 Handbook of Agriculture (3). They are, of course, mean values; numbers of samples and standard errors are presented in the Handbook tabulations. Animal fat profiles are influenced by dietary regimen, season of slaughter, age at slaughter, and by adipose depot location. The tabulations cover only the main fatty acids. They fail to catalog the branched, *trans* and odd-carbon-number fatty acids, which are found as a few percent of total fatty acids in ruminant fat. They also neglect to address positional assignments on the glycerol backbone.

Table 2 highlights the major difference between animal fats and vegetable oils - the degree of unsaturation. Aside from any dietary considerations, it is of course this difference that is largely responsible for the differences in physical properties of these different types of triglyceride lipids. Only 4% of the fatty acids of beef tallow and butteroil are polyunsaturated, in contrast to 61% of soy oil fatty acids. Palm oil, however, is traded for its high saturation, and it is evident from the profiles why it is considered to be a competitor to beef tallow. Note the high degree of polyunsaturation in chicken fat.

If we look more closely at the saturated fatty acids (Table 2), we again see that butteroil has the highest concentration of the saturates, chicken fat the least of the animal fats, and soy oil - at least before hydrogenation - the lowest of the set. Myristic and palmitic acids, which are of concern as a component of the human diet, do not in their sum vary too much among the fats. Even the fatty acids of chicken fat, only 30% saturated, contain over 22% of the discredited fatty acids.

By far, the most prevalent fatty acid of beef tallow is oleic. In fact, in the United States, tallow is the primary feedstock for the production of oleic acid. Mutton tallow is similar to beef tallow. Sheep and cattle are ruminants; ruminal microflora biohydrogenate dietary polyunsaturated acids, increasing the saturation and incorporating a few percent of *trans* fatty acids as well. This is true for butterfat, too. Swine, on the other hand, are nonruminants, and their fat, lard, does not have significant amounts of *trans* fatty acids. Lard is characterized by somewhat more polyunsaturates

than beef or mutton tallow. Due to a lack of natural antioxidants, lard is less stable than vegetable sources with an equal level of saturated fatty acids.

Table 2: Lipid and Proximate Profiles for Commercial Fats and Oils

	Beef Tallow	Mutton Tallow	Lard	Butteroil (anhyd.)	Chicken	Palm	Soy
% lipid	100.0	100.0	100.0	99.48	99.8	100.0	100
% water	0.0	0.0	0.0	0.24	0.2	0.0	0
% ash	0.0	0.0	0.0	0.00	0.0	0.0	0
% protein	0.0	0.0	0.0	0.28	0.0	0.0	0
Saturated (g/100g fat)	**49.8**	**47.3**	**39.2**	**61.9**	**29.8**	**49.3**	**14.4**
4:0				3.2			
6:0				1.9			
8:0				1.1			
10:0			0.1	2.5			
12:0	0.9		0.2	2.8	0.1	0.1	
14:0	3.7	3.8	1.3	10.0	0.9	1.0	0.1
16:0	24.9	21.5	23.8	26.2	21.6	43.5	10.3
18:0	18.9	19.5	13.5	12.1	6.0	4.3	3.8
Monounsatd (g/100 g fat)	41.8	40.6	45.1	28.7	44.7	37.0	23.3
16:1	4.2	2.3	2.7	2.2	5.7	0.3	0.2
18:1	36.0	37.6	41.2	25.0	37.3	36.6	22.8
20:1	0.3		1.0		1.1	0.1	0.2
22:1							
Polyunsatd (g/100g fat)	4.0	7.8	11.2	3.7	20.9	9.3	57.9
18:2	3.1	5.5	10.2	2.3	19.5	9.1	51
18:3	0.6	2.3	1.0	1.5	1.0	0.2	6.8
20:4					0.1		
cholesterol (mg)	109	102	95	256	85		
tocopherol (mg)				2.83	2.7	38.4	93.7

Chicken fat, with 21% polyunsaturated fatty acids, is the most polyunsaturated of the fats of Table 2. Most poultry fat, incidently, disappears into poultry rations in what is a vertically integrated industry.

Butteroil offers the most complex fatty acid profile of any natural fat or oil (4).. The high content of saturated fatty acids is replete with short and medium chain fatty acids that - together with lactones, ketones and aldehydes, sulfides, and alcohols - impart flavor to the commodity. Of course, butter has given its name to the C4 acid, butyric. The profile is influenced by diet and varies seasonally.

Finally, no discussion of constituents of animal fats is complete without mention of cholesterol. Table 2 illustrates that cholesterol content is not drastically different from fat to fat, with the exception of the high content found in butteroil.

2. PRODUCTION AND CONSUMPTION DATA

2.1 Tallow and Grease

Where does the world's supply of tallow originate? Listed in Table 3 is the 1993 production of 20 producers in the world (5). Ignoring for the moment the production of the United States, it should not be surprising to find Australia, Brazil and Argentina high on this list. Notice the productivity of China and Russia. Neverthless, US production is overwhelming (51% of the production of the top 20 producers).

Table 3: Tallow Production, Major Producers in 1993 (thousand metric tons)

United States	3270	Korea, Rep. of	140
Australia	470	Denmark	135
Brazil	282	New Zealand	131
Argentina	276	Spain	100
United Kingdom	216	Italy	95
Canada	210	China	90
France	195	Russia	85
Germany	194	Ireland	65
Japan	155	Mexico	60
Netherlands	155	Poland	50

Table 4: Production, Supply and Distribution of Agricultural Commodities: Livestock, 1993
(thousand head)

	CATTLE						SWINE	SHEEP
	Beginning Stocks	Production	Total Imports	Total Exports	**Total Domestic Use**	Ending Stocks	**Total Domestic Use**	**Total Domestic Use**
Top 20 Ranked Tallow Producers, 1993								
USA	101749	35300	2700	270	**35185**	104294	**90425**	**5000**
Australia	25837	8775	0	150	**8302**	26160		**32039**
Brazil	128879	21700	0	0	**22400**	128179	**14400**	**NA**
Argentina	55079	12100	0	5	**12300**	54874		**5200**
United Kingdom	11893	3680	76	440	**3420**	11789	**14940**	**19505**
Canada	12028	4715	65	1300	**3300**	12208	**15550**	**NA**
France	21070	7614	350	1764	**6270**	21000	**25180**	**9500**
Germany	15891	5425	325	550	**5400**	15691	**40975**	**2250**
Japan	5055	1495	16	0	**1504**	5062	**18690**	**NA**
Netherlands	4600	1700	700	150	**2300**	4550	**19844**	**NA**
Korea, Rep. of	2814	888	0	0	**790**	2912	**10600**	**NA**
Denmark	2115	785	0	30	**770**	2100	**20400**	**NA**
New Zealand	8300	3230	0	6	**2984**	8540		**30950**
Spain	4800	1605	390	57	**2000**	4738	**27145**	**20140**
Italy	7600	3165	1650	15	**4900**	7500	**12379**	**8600**
China	110000	21140	0	140	**19000**	112000	**390000**	**115000**
Russia	49500	16500	0	0	**17500**	48500	**30000**	**17400**
Ireland	6308	2007	9	350	**1580**	6394	**3300**	**4550**
Mexico	30669	9270	200	1350	**8010**	30779	**12350**	**8310**
Poland	7262	2938	150	300	**2950**	7100	**19550**	**200**
Other countries								
India	271805	23691	0	0	**21268**	274228	**NA**	**61263**
Ukraine	21500	5750	973	0	**7368**	20855	**11628**	**1750**
Colombia	16704	3600	2	63	**3252**	16991	**NA**	**NA**
Venezuela	15159	2416	30	0	**1840**	15765	**1900**	**NA**
Uruguay	10380	1830	0	10	**1490**	10710	**NA**	**11300**
Turkey	11850	4050	250	0	**4350**	11800	**NA**	**23900**
Kazakhstan	9400	2964	809	0	**3716**	9457	**2542**	**17188**
Costa Rica	1694	375	40	0	**440**	1669	**NA**	**NA**

One might think that there is a relationship between tallow production and the consumption of meat animals. Table 4 shows some anomalies. The top 20 producers are listed first. Although the United States is the top consumer of cattle, the cattle consumption data do not dwarf the others listed, as did U.S. production data. China, Russia and India consume large numbers of cattle, but their tallow production doesn't corroborate. One reason is that U.S. feedlot operations produce cattle with high yields of rendered fat (50-55 kg/head).

Note also the huge consumption of sheep consumed in China and India, and China's tremendous consumption of pork. Regarding hog consumption in the USA, an American hog yields about 11 kg of fat. Slaughter weight is up, but the extra weight is meat, not fat.

The lesson is that there is no clear correlation between domestic consumption of animals and the production of tallow and grease. Other factors include feedlot finishing, an infrastructure that handles tallow and grease as items of trade, and - of course - the validity of published data.

Table 5 illustrates that Russia is not a major importer of tallow. China does import "modest" amounts (35,000 metric tons in 1993). At the top of that category is the Netherlands, followed by Mexico and Spain. Pakistan imported 100,000 metric tons; India's figures were not given (5).

Export figures (Table 5) show that the USA exported 37% of its production in 1993 and Australia 60%, but the third-ranked producer, Brazil, exported far less than 1% of its production and fourth-ranked producer Argentina only 2% (5).

Tables 6 tracks tallow and lard consumption for the United States, the world's largest market for rendered products (6). Figures for 1994 (7) are estimates. Over the last the four years shown here, total rendered products in the USA have increased by 7%.

There is steady growth in the use of tallow in animal feeds, which have been the major target for these rendered products for a number of years. At the same time, there has been declining use of inedible tallow and greases for soap, lubricants and fatty acids.

Table 5: Tallow Imports and Exports, 1993 (thousand metric tons)

	Imports	Exports		Imports	Exports
Top 20 Producers:			Italy	90	20
USA	20	1200	China	35	1
Australia	1	281	Russia	1	1
Brazil	40	1	Ireland	3	62
Argentina	1	5	Mexico	230	1
United Kingdom	79	12	Poland	1	3
Canada	23	200	*Others:*		
France	50	75	Belgium/Luxembourg	135	18
Germany	65	195	Pakistan	100	
Japan	105	1	Venezuela	83	
Netherlands	295	75	China (Taiwan)	80	
Korea, Rep. of	125	1	Turkey	70	5
Denmark	41	37	Colombia	67	
New Zealand	1	120	El Salvador	52	
Spain	185	1	Bulgaria		3

Table 6: Tallow and Lard Consumption, USA (thousand metric tons):

	Tallow							**Lard**		
	Total	**Edible**			**Inedible**			**Total**	**Edible**	**Inedible**
		Total	*as edible*	*as inedible*	Total	*as feed*	*as other*			
10/86-9/87	**1823.5**	444.2	*413.0*	*31.1*	1379.3	*770.6*	*608.7*	136.6	*109.3*	*27.4*
10/87-9/88	**1856.1**	432.9	*391.7*	*41.1*	1423.3	*825.7*	*597.6*	157.6	*127.1*	*30.5*
10/88-9/89	**1818.9**	418.8	*353.4*	*65.4*	1400.1	*873.3*	*526.8*	176.9	*147.2*	*29.7*
10/89-9/90	**1844.0**	383.9	*320.4*	*63.5*	1460.1	*899.4*	*560.7*	167.5	*137.8*	*29.7*
1/91-12/91	**1615.3**	277.5	*210.1*	*67.4*	1337.8	*793.1*	*544.7*	178.3	*142.3*	*36.0*
1/92-12/92	**1653.4**	269.9	*194.7*	*75.2*	1383.5	*886.5*	*497.0*	217.6	*156.5*	*61.1*
1/93-12/93	**1624.0**	255.0	*185.5*	*69.5*	1369.0	*904.8*	*464.3*	214.7	*147.2*	*67.4*
1994 est. (7)	***1730.4***	*252.5*	*189.6*	*62.9*	*1477.9*	*991.3*	*486.6*	*191.4*	*133.7*	*89.4*

Statistics for U.S. consumption of edible tallow show a decline, but these data do not reflect the recent rise in use of edible tallow for inedible purposes. Less than a quarter of all edible tallow has been used for inedible purposes. Incidently, the use of inedible tallow for edible purposes is not tracked.

The price differential between inedible and edible tallow has been so small recently that the price barrier against using edible tallow for inedible use is marginal. Tallow prices are moved by the price of palm oil, a competing commodity for stearine. Palm oil prices soared in 1994, due to expectations of a dismal crop. Data in Table 7 demonstrate how prices for tallow, grease and lard all responded to the rise in vegetable oil prices. The difference in price between edible and inedible tallow was only one cent per pound in early September 1995, but it had been four cents per pound at the beginning of the year (8).

Table 7: Market Prices for Fats and Oils (US cents/pound)

Date	Inedible Tallow(*)	Edible Tallow	Yellow Grease	Lard (Loose)	Palm (Crude)	Soy (Crude)
7 Feb 1994	14.75	16.75	13.50	14.50	21.13	29.38
6 Jun 1994	16.00	16.75	13.50	15.75	26.50	28.80
5 Sep 1994	19.00	20.50	14.00	20.00	30.13	26.31
5 Dec 1994	20.50	23.50	14.75	20.75	36.00	30.25
2 Jan 1995	22.00	26.00	15.50	21.00	33.25	30.00
6 Mar 1995	18.00	21.00	14.00	20.00	33.50	28.00
5 Jun 1995	17.50	19.50	15.00	18.50	31.50	26.25
4 Sep 1995	20.50	21.50	14.50	21.50	30.50	26.25

*Renderers fancy bleachable.

Statistics on the U.S. consumption of lard also show that about a quarter of the commodity is used for inedible purposes (Table 6). The major use of edible lard is shortening. Lard and tallow are prized by the food industry for flavor and textural properties not matched by vegetable oils. Inedible lard is used in animal feed and for lubricants and fatty acid production.

In the former "Eastern Bloc," there has been a steady decline in production of all animal fats. Table 8 tracks this decline for eastern Europe and the former Soviet union from 1989 through 1993. Production is seen to decline for total fat, for butter, for lard and for tallow (9) .

2.2 Butteroil

Table 9 shows information on the worldwide production and trade of butter over several years. Table 10 gives details for the EC and the United States. These data are taken from the 15th Annual Report of the International Dairy Arrangement (IDA) (10). The 16 IDA participants consist of the EC-12 plus Argentina, Australia, Bulgaria, Egypt, Finland, Hungary, Japan, New Zealand, Norway, Poland, Romania, South Africa, Sweden, Switzerland, and Uruguay. The IDA members agree to certain protocols, including minimum export prices for their products. Those participants that are among the world's largest producers are the EC-12, New Zealand and Poland. Large producers NOT part of the IDA include India and Pakistan, Russia and Ukraine, and the United States. Butter production by the world's major producers in 1993 is given in Table 11.

Table 8: Production of Butter, Lard and Tallow in the former "East Bloc" Countries

	TOTAL	Butter	Lard	Tallow
East Europe				
1989	1251	451	633	167
1990	1240	431	632	177
1991	1082	318	602	162
1992	959	269	547	143
1993	898	252	516	130
Former Soviet Union				
1989	2661	1353	853	455
1990	2649	1356	842	451
1991	2308	1178	733	397
1992	2102	1140	616	346
1993	1984	1085	581	318

The IDA report concludes that world butter production is in a small but steady decline. On-going economic transitions in East Europe have been responsible for the sharp decline in butter production in those countries. Those markets traditionally consume great amounts of butter, and importations have soared, backed by special pricing and credit arrangements. World per capita

consumption, which was level throughout the 1980's, has suffered an average 2% decline since 1991.

World butter stocks are only about a third of what they were 15 years ago. Not shown in Table 9 is the sharp decline in the stocks of U.S. butter in 1994, mainly resulting from the deliberate distribution of surplus U.S. stocks. American stocks are expected to rebound in 1995, compounded by increased butterfat production resulting from the use of bovine somatotropin (bST) for inducing greater milk production.

Table 9: World Butter Production and Trade (thousand metric tons)

	Production	Consumption	Exports	Imports	IDA Stocks, 1 July	US Stocks, 1 July
Avg 1985-9	7622	6606	896	888	1007	162
1990	7695	6439	720	590	376	189
1991	7410	6310	720	572	543	370
1992	7063	6150	600		452	347
1993	7032		550		433	292
Above Data Normalized to Averages of 1985-1989:						
Avg 1985-9	100%	100%	100%	100%	100%	100%
1990	101%	97%	80%	66%	37%	117%
1991	97%	96%	80%	64%	54%	228%
1992	93%	93%	67%		45%	213%
1993	92%		61%		43%	180%

Table 10: EC and US Butter Production and Trade (thousand metric tons)

	Production	Consumption	Exports	Imports
EC				
Avg 1985-9	1801.8	1795.3	335.6	77.8
1990	1605.0	1370.0	112.0	88.0
1991	1635.0	1527.0	209.0	68.0
1992	1506.0	1475.0	140.0	48.0
1993	1528.0	1523.0	99.0	60.0
US				
Avg 1985-9	542.3	499.0	10.3	1.5
1990	590.7	578.7	52.4	2.6
1991	606.0	482.0	23.0	1.4
1992	619.0	485.0	95.7	0.9
1993	598.1	518.0	120.7	2.2

Table 11: Major Butter Producers, 1993 (thousand metric tons)

EC	1,528	Pakistan	334
India (include. ghee)	1,110	Ukraine	325
Russia	700	New Zealand	198
United States	598	Poland	139

Production, though not consumption, continues to decline in the EC-12, according to projections through 1995 published in Agra Europe (11). However, taking into account the surplus production of the EC's newest members - Austria, Sweden and Finland, the expanded "EC-15" will show a surplus of production over consumption.

1994 estimates for the USA made by the USDA's Economic Research Service actually anticipated slight decreases in production and consumption, but 1995 estimates by the same project a 3% increase in domestic production (12).

Table 12 illustrates world trade in butter (10). Note that not all IDA participants are net exporters of butter. The trade data for the EC excludes trade among the EC-12 member states. Note that the former USSR is a major importer of butter, thanks to special marketing arrangements mentioned previously, and that such importations offset internal production that - as discussed before - has been declining steadily since 1989.

Table 12: Butter Imports and Exports, 1993 (thousand metric tons)

	Exports	Imports		Exports	Imports
New Zealand *	196	-0.3	Poland *	17	6.1
USA	120.7	2.2	Switzerland *		6.2
EC-12 *	99	60	Algeria		43
Australia *	40.9	1.9	Egypt *		45
Sweden *	21.4	0.5	Former USSR		169.9
Finland *	17		**IDA Total**	**410.2**	**128.7**

* IDA participant

3. TRENDS

In early 1995, Don Headley, Director of London-based Market Tracking International, summarized key trends in the fats and oils sector (13). Table 13 highlights some of these.

Table 13: Key Trends in the Fats and Oils Sector

- Animal Fat Production
  - –Ever-lower proportion of total fats & oils production
- Dietary Trends
  - –Reduced fats and calories
- Animal Fat Decline
  - –Fast food industry's switch to vegetable oil
  - –Aversion by the young
- Butterfat Decline
  - –Health consciousness
  - –Price advantage of margarine
  - –Growth in margarine in N. Europe (esp. Germany, UK)
  - –Growth in low-fat spreads (esp. UK)
  - –Butter still dominates in France, Spain, Italy
  - –Amelioration: Occasional-treat buying
  - –Amelioration: Dairy spreads (cream and vegoil)
- Trade Environment
  - –Levy reductions under GATT: More imports into EU
  - –Vegoil production rises with meal demand (esp. USA)

Animal fat production constitutes less and less of the world's total production of fats and oils (17-25% now - depending on sources of data). Edible animal fats suffer not only from the trend toward reduced caloric intake, but also to an aversion - especially by the young - against animal fats in particular. Two "C-words" are affecting the market: calories and cholesterol. Fast food operations, which once took advantage of the flavor benefits derived from frying in animal fat, have switched to vegetable-derived frying fats. Synthetic fats may replace a third of all vegetable oil consumption in the USA by the year 2000.

The aversion against animal fats is compounded by growth in margarine sales and low-fat spreads. Butter still dominates the market in France, Spain and Italy. Those who have switched from butter will occasionally buy butter products as treats. Dairy spreads, in which vegetable oil is supplemented by cream for flavor, also will help maintain some of the market for butterfat. The elimination of import restrictions under GATT should open the European market to imports of butter. Growth in the vegetable oil market, especially in the USA, will be stimulated by rising demand for oilseed meals.

The production of butter will not be curtailed so long as milk is marketed by its butterfat content. There have been many calls to market milk on its protein content. The traditional method is very well entrenched, but growing demand ironically for milk proteins by a health conscious public that disdains butterfat may lead to changes in the near future.

4. USES

Table 14 is a reminder of the numerous products made from fats and oils. The high amount of saturation in animal fats does not favor their derivatization into some of these products, but certainly soaps, detergents, and heavy-metal soaps for lubricating greases may be derived from animal fats. Fatty acids are split out and glycerol recovered from all fats and oils. Fatty acid methyl esters are intermediate products that are converted to fatty alcohols for use in the detergent and plasticizer markets.

Biodiesel can be an important outlet for animal fats in the future. The use of methyl esters of fatty acids for such fuel is promoted strongly by soy interests in the USA and is commercialized in Europe using rapeseed and sunflower oil as feedstock. Vegetable oil feedstock constitutes 70% of the cost of biodiesel production, so there is a cost benefit to substituting animal fats for more costly vegetable oils. Bear in mind, however, that the primary market for animal fats now is none of the above products; more than half of the commodity ends up in animal feed.

Table 14: Products from Fats and Oils

• Alkyd Resins (paints)	• Lubricants	• Cosmetics
• Polyesters	• Lubricating Greases	• Plasticizers
• Polyurethanes	• Detergents	• Epoxidized Oils
• Nylons	• Bar Soap	• Glycerol
• Biodiesel	• Emulsifiers	

5. RESEARCH AND DEVELOPMENT

Some research thrusts are highlighted in Table 15. Biodiesel was already mentioned as a potentially important outlet for animal fats in the future. Research now aims to improve the cold temperature properties of animal fat-derived biodiesel, such as by transesterification using branched alcohols in place of methanol. Enzymatic synthesis of biodiesel esters will also allow the use of high free-fatty acid feeedstocks such as yellow grease (14). Reported elsewhere in the ISF Proceedings is a new process by deSmet[2] for transesterifying triglycerides to methyl esters using a titanium-based organometallic catalyst (15).

Table 15: Research Thrusts

Depot Fats	Dairy Fats
• Biodiesel	• Encapsulation
—Tallow, yellow grease	—By starch and sugars
• Bacterial Polymers	—By whey solids
—PHA's	• Fractionation
• Selective Harvesting of	—Solid: confectionery use
Fatty Acids	—Liquid: spreadables
—Selective lipases	• Increased Production
• Reduced Production	—bST
• Dietary repartioning	• Reduced Production
Agents	—Breeding

Bacteria are known to synthesize biodegradable polyesters called poly(hydroxyalkanoates), PHA's. Short-chain PHA's of butyrate and valerate - PHB/PHV copolymers - are produced in limited commercial quantities. Research is examining tallow and greases (16) and vegetable oils (17) as substrates for PHA production.

[2] Mention of a brand or firm name does not imply endorsement by the U.S. Department of Agriculture over other brands or firm names not mentioned.

Lipase selectivity can be utilized to harvest fatty acids from all sources, based on the fatty acid's chain length, unsaturation, and position on the glycerol backone. This is reviewed elsewhere in the ISF Proceedings by Thomas Foglia (18).

Thyromimetic agents are being investigated in poultry to repartition between adipose and muscle deposition. The goal of course is a leaner bird, with more food energy channeled into production of meat (19). Likewise, beta agonists have been very successfully applied to swine (20).

Not mentioned in the table is the potential use of tallow to coat large, round hay bales to prevent spoilage by moisture penetration during open-air storage. Indirectly, of course, such tallow would end up as part of animal feed rations, currently the largest market for tallow (21).

In dairy research, encapsulation of butterfat using starch, sugars or whey solids could revolutionize the preservation, storage and use of that commodity. For example, encapsulation in starch, sucrose, maltose or lactose allows butter to be stored at ambient temperatures for over a year. The product then is incorporated directly into recipes as an alternative to intact butter (22).

Fractionation of butterfat leads to a solid fraction for confectionery use and a liquid fraction for spreadables. This parallels earlier research done on tallow. Other components could be used as cosmetic emoliants, antioxidants, anticarcinogenic agents, and surfactants. This research was targeted to the utilization of large stocks of surplus butter, surpluses which might be eliminated by heavy export demand of the whole product (23). Cholesterol removal is also the objective of continuing research. Methods under evaluation include countercurrent extraction using propane and ethanol, complexation with saponins, and steam distillation (24).

Bovine somatotropin (bST) is being used in the USA on dairy cows for increased production of milk - and thus increased production of butterfat (25). Reduced production can be achieved by selectively breeding back toward the Guernsey breed. Guernsey milk contains less than 3% butterfat, whereas Holsteins, for example, produce milk at the 4% butterfat level.

To conclude, animal fats are a diminishing fraction of the world's total production of fats and oils. Nevertheless, as long as there is a market for meat and dairy proteins, there will be fat coproducts for which there is a good market. New products and processes will continue to be developed to take advantage of the sometimes unique characteristics of these fats.

REFERENCES

1. Anon. (May 1994) *Oilseeds: World Markets and Trade*, USDA Foreign Agricultural Service, Washington, DC.
2. Anon. (January 1995) *Frost and Sullivan Report: European Oleochemical Markets*, London.
3. Reeves, J.B., and Weihrauch, J.L. (June 1979) *Composition of Foods*, Agricultural Handbook No. 8-4, USDA, Science and Education Administration, Washington, DC.
4. Gunstone, F.D., Harwood, J.L., and Padley, F.B. (1994) *The Lipid Handbook*, 2nd Ed., pp147ff.
5. Anon. (1994) *Production, Supply and Distribution of Agricultural Commodities*. USDA Foreign Agricultural Service.
6. Anon. (December 1994) *Situation and Outlook Report: Industrial Uses of Agricultural Materials*, USDA, Economic Research Service.
7. Blanton, B. (April 1995) *Render*, 10-16; data are derived from Bureau of the Census, U.S. Department of Commerce, M20K series for Fats and Oils, Production, Consumption and Stocks.
8. *Chemical Marketing Reporter*.
9. Mielke, T. (1994) *Inform* 5(8):872-884.
10. Anon. (November 1994) *The World Market for Dairy Products 1994. 15th Annual Report of the International Dairy Arrangement*, General Agreement on Tariffs and Trade, Geneva.
11. Anon. (1995), *Agra Europe*, 6 Jan., p. M/2.
12. Anon. (1993) *Situation and Outlook, Dairy Outlook, 23 June*, USDA, Economic Research Service.
13. Headley, D. (1995) *Oils & Fats International* 11(2): 52-54.
14. Nelson, L., Foglia, T. A., and Marmer, W. N. (1996) *J. Am. Oil Chemists' Soc.* in press.
15. Grangé, C. (1995) *Proceedings of the 21st ISF World Congress, The Hague, The Netherlands, October 1995*, P. J. Barnes Associates, High Wycombe, England, 13B-B.
16. Cromwick, A.-M., Foglia, T.A., and Lenz, R.W. (1996) To *Applied Microbiol. Biotech.*
17. (a) Eggink, G., van der Wal, H., Huijberts, N.M., and de Waard, P. (1995) *Can. J. Microbiol.* 43 (suppl. 1):14-21; (b) Eggink, G., Huijberts, G.N.M., and van der Wal, H *Proceedings of the 21st ISF World Congress, The Hague, The Netherlands, October 1995*, P. J. Barnes Associates, High Wycombe, England, 2P-B.
18. Foglia, T.A., Piazza, G.J., and Sonnet, P.E. (1995) *Proceedings of the 21st ISF World Congress, The Hague, The Netherlands, October 1995*, P. J. Barnes Associates, High Wycombe, England, 2C-B.
19. Foglia, T.A., Cartwright, A.L., Gyurik, R.J., and Philips, J.G. (1994) *Lipids* 29(7):497-502.
20. Mersmann, H.J. (1990) *Metabolic and Endocrine Control of Adipose Tissue Accretion*, Chapter 4 in Wood, J.D., and Fisher, A.V., *Reducing Fat in Meat Animals*, Elsevier Applied Science, London and New York, pp. 101-143.
21. Anon. (January 1995) *Frost & Sullivan Report: European Oleochemical Markets*, London.
22. Onwulata, C., Smith, P.W., Konstance, R.P., and Holsinger, V.H. (1995) *Food Technology* 49(3):82-90.
23. Anon. (April 1995) *Prepared Foods*, 164(4):36.
24. Mann, E. (February 1995) *Dairy Industries International* 60(2):19.
25 Anon. (October 1987) *bST and the Dairy Industry: A National, Regional, and Farm-Level Analysis*. USDA, Washington, DC.