

Summary

The U.S. economy is expected to grow robustly in 2004 and 2005. Growth of 4.7 percent is expected in 2004, fueled by continued strong productivity gains, expansionary monetary and fiscal policy, strong business capital spending and inventory expansion, and rising foreign growth. Strong 2005 economic growth will be fueled by robust productivity growth and increased business capital spending.

Higher income growth is the primary factor adding to the high standard of living in the United States, and it overshadows slowly evolving demographic and social characteristics. Higher income encourages consumers to spend discretionary incomes on food quality, variety, and convenience. As income rises, consumers tend to increase their expenditures on more expensive fresh foods, more processed food, and more eating away from home.

Conventional food retailers are now actively competing with a variety of other retail outlets, including discount supercenters and warehouse stores. Retailers are also competing with restaurants by offering a variety of convenient, ready-to-eat foods. The increased competition between at-home and away-from-home outlets has blurred the distinction between these two markets.

Food prices are expected to increase 2.5 to 3.5 percent in 2004. The overall improvement in the U.S. economy, along with strong consumer demand for products whose production costs are rising, will produce higher food price inflation in 2004. In 2005, this trend will continue, and prices will rise an additional 3.0 to 4.0 percent.

Crop prices are at their highest levels since 1998. Farm prices are expected to rise 10 percent for corn and 14 for soybeans. Livestock prices are also expected to rise. U.S. beef exports have been sharply curtailed, following the discovery of BSE in the United States. Nevertheless, strong domestic demand and declining beef production will still yield the second highest farm price of the last 11 years. Similarly, broiler prices are expected to rise 13 percent in 2004. Strong consumer demand for broilers will more than compensate for the temporary loss of export markets following the discovery of avian influenza. Domestic pork demand is also strong. Moreover, pork demand is likely to be bolstered by export markets, which use pork as a substitute for banned beef and chicken products. Therefore, farm prices for pork will also rise.

Macroeconomic Outlook

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STRONG U.S. GROWTH EXPECTED IN 2004 AND 2005

The U.S. economy is expected to continue to grow robustly in 2004 and 2005. Growth of 4.7 percent is expected in 2004, fueled by continued strong productivity growth, expansionary monetary and fiscal policy, strong business capital spending and inventory expansion, a favorable financial environment in debt and markets, and rising for-

ign growth. Strong economic growth in 2005 will continue to be fueled by robust growth in productivity and business capital spending.

Growth is expected to slow to 3.8 percent in 2005, as higher real interest rates slow residential, consumer, and, to a much lesser extent, business capital spending. Fiscal policy is expected to be less expansionary as growth in government spending slows. The pace of inventory expansion is expected to slow in 2005 as inventories are brought more sharply in line with expected sales. Somewhat weaker foreign growth (relative to very strong 2004 levels), led by expected slower growth in non-Japan Pacific Asia, will be an additional mild drag on U.S. growth in 2005.

Inflation is expected to be slightly higher in 2004 and 2005 as moderately tighter labor markets and the strong productivity growth of recent years leads to stronger growth in wage and benefit demands. Sharply higher commodity and energy prices are also pushing inflation upward. However, inflation will remain very low by historical standards due to continued strong productivity growth and excess capacity in many resource markets, most notably manufacturing. Interest rates will be under pressure from slightly higher inflation, a tightening of monetary policy, stronger corporate and foreign credit demand, and continued large government deficits.

The dollar will continue to be very volatile. Although the dollar is likely to continue downward, its pace of decline is expected to moderate, especially in 2005. Continued low rates of private U.S. saving, large government deficits, and stronger foreign credit demand will put downward pressure on the dollar. The fall in the dollar will be moderated by two factors. First, there will be continued strong U.S. productivity growth relative to the rest of the world. Second, real interest rate differentials between foreign countries and the U.S. will narrow over the course of 2004 and especially 2005.

INFLATION TO RISE SLIGHTLY IN 2004 AND 2005

Inflation is expected to be slightly higher in 2004 and 2005, as prices will be under upward pressure from higher commodity and energy prices coupled with stronger wage and benefit demands. Wages and benefits will rise from the effects of somewhat tighter labor markets and the strong productivity growth of recent years. However, inflation will remain very low by historical standards due to continued strong productivity growth and excess capacity in many resource markets, most notably manufacturing. Inflation, as measured by the GDP chain-weighted deflator, is expected to rise 1.9 percent in 2004 and 2.0 percent in 2005.

INTEREST RATES UNDER UPWARD PRESSURE IN 2004 AND ESPECIALLY 2005 WHILE THE DOLLAR IS EXPECTED TO TREND LOWER

Monetary policy tightening will likely occur in late summer or in early fall of 2004. Federal Reserve tightening will be moderate overall, given continued low inflation, strong productivity, and substantial excess capacity in many goods markets. Monetary tightening over the

next 2 to 3 years will be necessary to prevent a significant increase in inflation as the gap between actual and potential output in the United States narrows. Real long-term interest rates will rise over the course of 2004 and 2005 as returns to the longer term capital stock increase with higher rates of capacity utilization in the economy.

Large federal deficits, unless offset by domestic sources of credit, generate a high level of dependence on foreign capital inflows. Currently, large government funds demands resulting from large federal deficits coupled with the low supply of funds from households has been offset by relatively modest business credit demand, strong money growth from an expansionary monetary policy, and foreign capital inflows.

Eventually, as the share of dollar-denominated assets held in foreign portfolios rises and foreign investment opportunities improve, foreigners will be less willing to hold dollar-denominated assets. As foreign investors diversify away from dollar-denominated assets, downward pressure on the U.S. dollar will be generated. On a year-over-year basis, the real broad value of the dollar (as measured by the broad-based BOG index) is expected to fall 5.4 percent in 2004 and an additional 3.5 percent in 2005.

U.S. AGRICULTURE TO BENEFIT FROM STRONGER FOREIGN GROWTH AND A WEAKER U.S. DOLLAR

Stronger U.S. growth in 2003 and 2004 benefited agriculture by raising foreign growth. Foreign growth is expected at 3.6 percent in 2004 and 3.2 percent in 2005. Foreign growth in 2005 will be slowed by the combination of slower U.S. growth, higher world wide interest rates induced by tighter U.S. monetary policy, and a weaker U.S. dollar. Most developing countries in non-Japanese Pacific Asia and Central and South America are expected to experience strong growth in 2004 and 2005. Asia is the largest regional importer of U.S. agricultural exports, and developing countries typically have higher income elasticities for agricultural products. U.S. food and agricultural exporters will also benefit from a weaker U.S. dollar. Many agricultural commodities, especially basic grains, are highly substitutable across suppliers. Thus, U.S. food exports, which are more sensitive to exchange rate changes, will benefit the most from the lower value of the dollar. Higher world oil prices will continue to raise agriculture transportation, fertilizer, and insecticide costs, thus putting downward pressure on net farm income, which should be offset by expected higher farm prices.

Food Consumption and Expenditures

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Changing economic, demographic, and social conditions have been creating a strong demand for more convenience and safer and more nutritious foods. Higher income growth is adding to the high standard of living in the United States by overshadowing slowly evolving demographic characteristics. This growth encourages consumers to spend their discretionary incomes on food quality, variety, and convenience,

rather than additional quantities of food.

Although changing slowly, demographic changes are also contributing to this phenomenon. An aging population and educational attainments have enhanced the demand for these attributes. Consumers have become more concerned with their health and have improved their knowledge of nutritional foods. This development has led to the growth of new foods, such as low-carbohydrate varieties.

The demand for convenience, quality, and variety is expanding the opportunity for processors, manufacturers, and producers to add the attributes consumers demand, decreasing the relative value of the raw commodity input embodied in the final food product. Food markets have become segmented by the increased preference for differentiated products and prices tailored to differing tastes and budgets of various consumer groups.

U.S. economic growth is the primary determinant of away-from-home food expenditures. Households with higher incomes eat out more frequently and spend more money per visit than households with lower incomes. A comparison of income elasticities between the sectors illustrates this point. A 10-percent increase in income will cause household away-from-home food expenditures to rise 4.6 percent, compared with a 1.3-percent increase in the at-home market (David Davis and Hayden Stewart, "Changing Consumer Demands Create Opportunities for U.S. Food System," *Food Review*, Vol. 25, Issue 1, pp. 20.) As income rises, consumers tend to increase their expenditures on more expensive fresh foods, more processed food, and more eating away from home. Consumers tend to demand quality over quantity as real incomes rise.

Smaller households are also an important factor affecting away-from-home expenditures. In 1980, the average U.S. household consisted of 2.8 persons; it is about 2.6 people today and is projected to continue declining. Smaller households eat out more because of time and expense economies associated with the purchase and preparation of meals. Specifically, the amount of time spent per person tends to decrease as household size increases. Moreover, the per capita cost of meal preparation also decreases with rising family size.

Several important social factors are also affecting consumer food choices. First, health, nutrition, and safety concerns are taking center stage. Information from the Centers for Disease Control and Prevention suggests that obesity is gaining on tobacco as the leading cause of preventable deaths in the United States. The rising rate of overweight and obese Americans has brought increased attention to healthy eating and lifestyles. Of particular concern, data from the Centers for Disease Control and Prevention suggests a growing rate of obesity among children.

Health concerns have elevated the demand for various diets, such as the Atkins low-carb, and for organic and natural foods. Leading food companies are responding by reexamining their product lines and marketing methods. Increased consumer awareness and a federal law requiring manufacturers to list trans fats on food labels by 2006 have sparked reformulation of food products. In 2003, products with "functional" food claims (i.e., emphasizing vitamins, protein, calcium, fiber,

or fruit content) accounted for 16 percent of new food product introductions, up from 15 percent in 2002 and 13 percent in 2001 (Brian Steinberg, "Food Makers Playing Up Nutrition," *Wall Street Journal*, March 26, 2004). The low-carb frenzy has even hit organic and natural product lines, while organic and all-natural lines are exhibiting double-digit growth in many categories. For example, organic milk has been growing 56 percent annually over the past 5 years.

Obesity has been argued to both reflect and affect contemporary trends in U.S. consumer demand for food. Obesity is reaching crisis proportions in the United States, with implications that will ripple throughout the food chain. About 65 percent of Americans are overweight or obese. Of this total, 31 percent are obese. These figures are roughly double the rate recorded in 1980. The number of severely obese people has increased 300 percent since 1986. Roughly 300,000 people die each year from causes attributable to obesity, including heart disease, stroke, diabetes, cancer, and other illnesses. Obesity rates have been growing across all ages, races, ethnic groups, genders, and geographic regions. Obesity rates, and the economic consequences of obesity, could continue to rise for many years to come. The Centers for Disease Control and Prevention estimates that obesity cost the U.S. economy \$117 billion in 2000, reflecting \$61 billion in direct medical costs and \$56 billion in lost productivity. Half of these costs are borne by taxpayers in the form of Medicare and Medicaid payments.

In 1980, the Dietary Guidelines for Americans was published, which advised Americans to reduce their intake of fat, cholesterol, and sodium and to increase consumption of fruits, vegetables, and grains. The impact of these recommendations is reflected in USDA consumption statistics. From 1980 to 1999, milk consumption declined 15 percent per person, while red meat consumption fell 10 percent. Meanwhile, fruit consumption rose an average of 4 percent, and vegetable consumption jumped 26 percent. Consumption of grains increased more than 33 percent. Moreover, mandatory nutrition labeling requirements led to further marketing of lower fat food alternatives.

Despite these trends, obesity has become more and more of a problem. Part of the explanation may lie in a 24-percent surge in the consumption of sugar and sweeteners from 1980 to 1999. Two basic explanations have been given. First, Americans enjoy relatively high incomes, resulting in a shift toward convenience foods. Americans are preparing less food at home and are eating a larger share at restaurants. Nearly half of the U.S. food dollar is now spent on away-from-home food purchases. People tend to consume more calories in away-from-home meals. Second, technological innovations have made Americans' lifestyles more sedentary.

Aggregate demand for food changes as a result of higher population, since there is a limit to the physical quantity of food any one person can consume. However, Americans are increasing their caloric intake of food. Women have increased their intake by 22 percent over the last 30 years, and men by 7 percent.

The Atkins Diet—While estimates of those participating in the Atkins diet and other low-carbohydrate ("low-carb") diets vary widely, the

low-carb market has grown rapidly to include mainstream players such as Coca-Cola, Nestle, Sara Lee, Frito-Lay, Hershey Foods, and Kraft, the nation's largest food company. Supermarkets are responding with more low-carb products, shelf tags, special low-carb shelf sections, special sections in weekly circulars, and other marketing concepts. Restaurant chains, such as Applebee's and TGI Friday's have developed low-carb menus, while fast food chains, such as Hardee's and McDonald's are offering burgers without the bun. In addition to new product introductions by low-carb distributors and manufacturers, mainstream manufacturers are offering new low-carb lines, reformulating existing products, or changing packaging to highlight their low-carb status. New foods and beverage introductions with low- and no-carb claims increased from 339 in 2002 to 633 in 2003, accounting for 3.4 percent of new food product introductions. These products range from low-carb salty snacks to chocolate confections.

Food Manufacturing and Distribution

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Food service and retail outlets are responding to shifts in consumer demand by competing to identify more processed and higher value-added products. The food service industry already offers Americans the convenience they desire. Retailers are now responding to consumer demand for convenience and healthful foods by offering a variety of processed, ready-to-cook, and ready-to-eat foods in a wider variety of formats. Retailers are blurring the line between at-home and away-from-home foods by offering products requiring minimal preparation. With higher incomes and rising consumer demand for prepared foods, these retail food products will serve as an increased source of competition with the away-from-home market. These products require more processing and labor inputs, causing marketing costs to rise. These well-established trends will become more pronounced during the next few years.

As food companies attempt to survive and grow market share, they are responding to a more time-pressed population, resulting in a phenomenon known as "channel blurring." Supercenters, such as Wal-Mart, warehouse clubs, and mass merchants provide convenient shopping, emphasizing low prices. By catering to price-conscious consumers and the convenience of one-stop shopping, these companies have expanded their share of food-at-home sales from 2.7 percent in 1988 to 9.9 percent in 2002. Recently, other nontraditional food outlets have been expanding their food business. To fuel part of their sales growth, pharmacies such as Walgreens and CVS are satisfying on-the-go consumers by expanding their food offerings. Food sales by drugstores are now \$7.25 billion, up 36 percent compared to 5 years ago. Dollar stores, such as Family Dollar and Big Lots, have emerged as potent competitors by appealing to bargain shoppers. Convenience stores that entice consumers with a mix of fuel, food, and specialty items are also emerging as legitimate contenders. As fuel margins stagnate and cigarettes face larger taxes and more societal pressure, food items provide an opportunity for these stores to increase margins.

These developments have spurred competitive responses, further

blurring the lines between what is sold at alternative outlets. Wal-Mart and Target are testing the dollar-store format within their stores. As traditional supermarkets struggle to maintain relevance in an increasingly competitive environment, they are slowly losing market share. These stores are caught in the middle of big-box retailers and upscale, premium outlets, such as Whole Foods Market and Trader Joe's. Supermarkets are responding by enhancing their service and product offerings. Some supermarkets are offering their own versions of discount grocery chains with limited assortments and also by experimenting with the dollar store concept. They are adding mini-Dollar-Store aisles and selling more organic foods, drugs, general merchandise, and fuel. Independent grocery stores are attempting to survive by offering specialty foods, such as hard-to-find ethnic items.

Catering to on-the-go consumers, supermarkets and food service companies are adding convenience products and added services. Home meal replacements for takeout are booming. A variety of pre-cooked, pre-cut, or pre-marinated meats are available for warming. Casual restaurants are also seeing big gains in the take-out business.

Intense competition in a domestic market that is growing by only .95 percent per year has generated a myriad of products from which consumers can choose. In 2003, food companies introduced 5,448 new food and beverage products with 17,234 stock keeping units.

At the same time, supercenters and other low price formats are keeping a lid on food prices. Supermarket chains have responded with their own initiatives based on Wal-Mart's supply chain principles, keeping price increases in check. Over the past several years, food and beverage prices have compared favorably to consumer prices in other industries. Correspondingly, the share of income spent on food continues to decline, freeing up income for other uses.

Retail Food Prices

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Increased consolidation among food retailers has left a smaller number of companies with a larger share of the retail food market. In 2003, the top four food retailers accounted for 25.5 percent of grocery sales, compared to 16.2 percent in 1995. Many industry analysts predicted that consolidation would create less competitive markets and higher food prices, with less pressure on retailers to develop and improve the quality of goods and services available to their customers. In fact, the opposite trend is being observed. As noted above, conventional food retailers are now actively competing with discount supercenters, club warehouse stores, convenience stores, and drug stores. These outlets are increasingly offering a larger array of food products to their price-sensitive and time-pressed customers. The share of at-home food sales for warehouse clubs and discount supercenters has surged from 1.8 percent in 1991 to 11.1 percent in 2003. Moreover, we have seen that conventional food retailers face increased competition from restaurants and other away-from-home institutions.

Conventional supermarkets have been forced to compete with these alternative food outlets by lowering prices and differentiating their

product from those available at their competitors. Recent retail food price developments reflect these market dynamics. The expanding services offered by retailers may increase their operating costs, but competitive pressure from the outlets listed above continue to keep prices for standard food items at relatively low inflation levels.

This trend of low aggregate food price inflation was reflected in a 2.2-percent increase in the Consumer Price Index for food during 2003. The CPI for all food is expected to rise 2.5 to 3.5 percent in 2004. The overall improvement in the U.S. economy, along with strong consumer demand for products whose production costs are rising, will produce higher food price inflation in 2004. In 2005, this trend will continue, and prices will be 3.0 to 4.0 percent above 2004 levels.

Food At Home—Food-at-home prices rose 2.2 percent in 2003, a slower pace than the annual average increase of the previous decade. In 2004, prices are expected to rise 3.0 to 4.0 percent. The overall improvement in the economy is the main source of this expected increase. Higher prices for eggs, milk, and meat will lead to the largest food-at-home price increase since 1996. These higher prices are primarily due to continued strong retail demand, despite tighter supplies of many food products. The primary factor that should mitigate the impact of changes in the aggregate economy is retail food market competition (discussed above) that will dampen these price increases. In 2005, food-at-home prices will begin to stabilize in the second half of the year, as producers adjust to the higher retail prices with increased production. However, prices will still be 2.5 to 3.5 percent above 2004 levels.

Food Away From Home—As noted earlier, consumers are eating out more frequently, reflecting higher demand for convenience for time-pressed consumers. Price inflation for food away from home in 2003 was slightly less than that for food at home—a common trend in post-recession years. At 2.1 percent, prices for meals purchased away from home posted the smallest rise since 1994. The expected improvement in the economy for 2004 suggests that consumers will be increasing their demand for food away from home, thereby accelerating the rate of price increases in this sector. The CPI for food away from home is expected to rise 2 to 3 percent in 2004, and 2.5 to 3.5 percent in 2005 in response to increased food production costs.

Agricultural Markets

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CROPS

Crop prices are at their highest levels since 1998, which are expected to stimulate a slight increase in aggregate planted acreage into 2004–2005. Total planted area for corn will rise about 2.2 percent, while soybean acreage will increase 1 percent. In 2003–2004, farm prices will climb 10 percent for corn, drop 5 percent for wheat, and surge 14 percent for soybeans. In 2004–2005, farm prices are expected to rise 6 percent for corn, remain about the same for wheat, and drop 19 percent for soybeans.

UNITED STATES

Wheat—Wheat production surged 45 percent in 2003–2004 due to improved weather conditions, which produced a sharp increase in yield per acre. Stronger export demand and demand for feed will not be sufficient to offset the large supply. Therefore, wheat prices will be 5 percent lower in 2003–2004.

Dry conditions in the Plains, along with cold weather and soggy soils in the Eastern Cornbelt are expected to reduce the harvested area in 2004. Moreover, the ratio of harvested-to-planted acres in 2004 is expected to be slightly less than the 10-year average. The projected yield for 2004 is also smaller than for 2003. Smaller production, although offset by larger carry-in stocks, leaves 2004–2005 supplies down about 6 percent from 2003–2004.

On the demand side, domestic food use will decline slightly. Two primary factors account for reduced per-capita wheat food consumption. First, changes in diets, (for example, the popularity of the Atkins diet) have reduced demand for carbohydrates, and thus, wheat products. Second, changes in baking technology have extended the shelf life of bakery products, thereby further reducing demand. On the other hand, feed use rose modestly, reflecting lower harvest wheat prices, which promote the use of wheat for feed. Moreover, higher prices for competing corn feed will further stimulate wheat demand for feed. Faced with higher European production and cheaper wheat from Russia and Ukraine, U.S. wheat exports are also expected to fall nearly 20 percent in 2004–2005. Overall, U.S. wheat disappearance in 2004–2005 is expected to decline about 8 percent.

With 6 percent lower supplies, ending stocks are expected to be slightly higher than a year earlier, leaving prices received by producers unchanged.

Soybeans—Soybean production fell 12 percent in 2003–2004, reflecting poor rainfall and extreme heat in August. Moreover, with lower South American soybean production and large volumes of Chinese imports, the sharply reduced global stocks will push farm prices to the highest levels of the last 20 years. The soybean inventory for March 2004 is the smallest of the last 15 years. These developments will raise U.S. soybean farm prices by 14 percent to \$7.60 per bushel, to the highest levels of the last 20 years. The tight supplies of the 2003–2004 crop will lend market strength to the 2004–2005 crop and provide the foundation for increased production.

Soybean production is expected to increase over 20 percent in 2004–2005, reflecting larger production acreage and recovery from 2003 yields, which were the lowest since 1993. Soybean supplies for 2004–2005 are projected to rise 18 percent over the previous year. Higher production is partly offset by lower beginning stocks, which are at a 27-year low.

Domestic soybean meal demand is expected to rise 8 percent as soybean supplies increase and soybean meal prices become relatively more competitive with other feed ingredients. Increased poultry production is also expected to boost soybean meal consumption. Meanwhile, domestic soybean oil use is expected to rise 6 percent, following a 4-percent drop in 2003–2004.

Growth in foreign soybean production has more than offset lower U.S. oilseed production over the past 2 years, especially in Brazil. A larger and more competitively priced 2004–2005 U.S. crop should result in an 18-percent increase in U.S. exports. Meal exports should jump 30 percent, while soybean oil will only rise modestly, reflecting strong competition from South American soybean oil.

Soybean ending stocks for 2004–2005 are forecast to rise 68 percent above the level for 2003–2004. Market prices are expected to average \$5.90 per bushel in 2004–2005. Relatively high soybean prices at the end of the 2003–2004 season and projected strong corn feed prices for 2004–2005 will partly offset the effect of increased U.S. stocks, record large South American soybean crops, and limited growth in foreign soybean import demand.

Corn—Corn use increased in 2003–2004, reflecting increased domestic use and higher exports. Moreover, the stronger U.S. economy translates into stronger demand for food, which drives the demand for animal feed. The index of grain-consuming animals reflects this trend, with a projected 1.3 percent increase which reflects increased numbers of cattle, hogs, and broilers on feed. Domestic industrial demand for corn is also higher. Ethanol accounts for over 1.1 billion bushels of corn use. U.S. corn prices are expected to rise about 10 percent in 2003–2004.

Corn production is forecast to rise 3 percent in 2004–2005, reflecting slight increases in area planted and harvested, along with the same yield forecast for 2003–2004. However, carrying stocks will be 17 percent lower, and total supplies are projected to rise 1 percent.

Feed and residual use is expected to decline in 2004 because of higher corn prices and a concurrent decline in beef production. Meanwhile, corn for food use is expected to rise in tandem with population growth. This market includes corn used to make high fructose corn syrup (HFCS), starch, and cereals. Corn for food is a “mature market” that trends in tandem with population growth and changes in the aggregate economy. However, HFCS is used primarily for soft drinks, which are being negatively affected by weight reduction campaigns.

Corn exports are expected to rise 5 percent this year, reflecting reduced competition from China and South Africa. In particular, Chinese farmers are expected to switch cropland to such crops as soybeans and cotton. Larger supplies of feed-quality wheat will mitigate this rise. Moreover, corn exports could be reduced by lower broiler production in Asian countries that were affected by an outbreak of avian influenza. However, increased poultry or pork production may absorb feed ingredients no longer consumed by the Asian poultry industry.

Ending stocks are expected to drop 9 percent in 2004–2005. Moreover, the ending stocks-to-use ratio is the lowest in 9 years. The projected farm price is up 6 percent.

LIVESTOCK

Beef—The liquidation phase of the current cattle cycle appeared to be ending as 2003 drew to a close. However, dry forage conditions and

very strong prices resulted in more cattle being placed in feedlots. The number of cattle and calves on farms had declined 1 percent as of January 1, 2004. Moreover, the number of breeders was down, along with those expected to calve. Therefore, 2003 saw the smallest calf crop since 1951.

Winter wheat conditions are poor, and drought conditions mean that water reserves need to be built up to support an increase in the number of cattle. Many pasture areas will be stressed, even with a return to "normal" weather conditions.

Cattle supplies are tightening. Commercial beef production is expected to drop 3 percent in 2004. Fewer cattle will be slaughtered, but average carcass weights should rise, thereby mitigating the overall production decline. In 2003, production dropped due to declining slaughter, poor feeding conditions, and a summer ban on Canadian beef imports. Therefore, feedlots marketed cattle as quickly as possible, producing lighter carcass weights. In 2004, cattle weights are expected to resume a more normal pattern. Beef export restrictions stemming from the discovery of BSE in Washington state greatly slowed the pace of slaughter. As prices respond to increased domestic beef supplies, feedlot operators will likely try to feed cattle to Choice grade, thereby driving up carcass weights.

Strong demand for beef, due to consumers' shift toward protein-based foods, resulted in record prices at the end of 2003. The discovery of bovine spongiform encephalopathy (BSE) in December has curtailed available export markets, meaning that U.S. prices must decline to clear the domestic market of these higher domestic supplies. However, the projected U.S. domestic price of \$74.50 per hundredweight is still the second highest fed cattle price of the last 11 years. This relatively high price reflects strong domestic demand and declining beef production following years of herd liquidation.

BSE. The U.S. sends about 90 percent of its beef exports to four markets: Japan, South Korea, Mexico, and Canada. After the discovery of BSE in December, most markets were shut to U.S. beef and beef products. Of the four leading markets, only Canada announced that it would take beef that was from cattle under 30 months of age. Because of the length of uncertainty of bans imposed on imported beef from the U.S., USDA assumes that bans currently in place will remain in effect until their removal. Thus, beef exports in 2004 are forecast at 220 million pounds—down from the record 2.5 billion pounds exported in 2003. The actual level of 2004 beef exports will be determined by how quickly major U.S. beef markets are opened again.

This single case of BSE reduced the value of beef exports by 97 percent and moved animal identification issues to the forefront. Prior to the discovery of the BSE in December 2003, efforts were already underway to develop a U.S. Animal Identification Plan (USAIP). In addition to government regulations imposed on packers and producers and more testing requirements, the BSE finding accelerated animal ID plans. The BSE incident increased the demand for the organic beef industry, where cattle are guaranteed 100-percent vegetarian organically fed.

Avian Influenza. The outbreak of avian influenza in 10 Asian countries (including Thailand and China, which are major exporters of broiler meat) led to the imposition of import bans by major importers such as Japan, South Korea, and Hong Kong. The U.S. is expected to increase broiler exports to some of these markets, but Brazil is most likely to be the major beneficiary. Brazil is able to produce more cheaply the products most demanded in Asian markets, such as deboned legs.

A less virulent strain of avian flu was reported in Delaware, New Jersey, and Pennsylvania in February 2004. U.S. trading partners immediately imposed bans on imports of U.S. broilers. However, it is expected that any bans blocking exports from the U.S. will become regional bans, assuming no further outbreaks. Therefore, broilers would be exported from states unaffected by the avian flu outbreak.

Moreover, corn exports could be reduced by lower broiler production in Asian countries affected by an outbreak of avian influenza. However, increased poultry or pork production may absorb feed ingredients no longer consumed by the Asian poultry industry.

It should be noted that the premium received for breast meat is currently driving the demand for broilers. Broiler prices are forecast to rise 13 percent in 2004. Consumer demand for chicken remains strong, reflecting perceived benefits of diets with reduced fat intake. Therefore, strong demand for domestic broiler meat and increased foreign demand for U.S. broilers contribute to the expected price strength at the farm level.

Pork—In 2003, pork production reached near record-high levels. However, pork prices were supported by the strong beef market and remained higher than in 2002. Fairly strong pork demand, especially from exports, is expected to produce steady pork prices relatively unchanged from 2003. Pork exports are expected to grow about 3 percent in 2004. Exports are likely to receive a boost from countries that have banned U.S. beef imports because of BSE and poultry because of avian influenza. Moreover, the weaker U.S. dollar favors U.S. exports over such competitors such as Denmark and Canada.

Milk—In 2003, producers received the lowest prices in 25 years. Production fell in the face of these low prices, and prices have climbed ever since. Reduced use of rBST is expected to keep milk production slightly below a year earlier. The all-milk price is expected to rise 11 percent over a year earlier. At the end of April, USDA raised the minimum price paid to dairy farmers by 50 cents. This action raises the minimum price paid to farmers to a record of \$1.69 per gallon. While there have been predictions of major price increases at the grocery store, it is too early to predict the effects of this decision.

Farm Income

In 2003, market receipts made up the highest share of net income since 1997. This trend is expected to continue into 2004. Prices for several agricultural commodities increased toward the end of 2003 and are expected to remain at these relatively high levels through 2004.

Corn, soybean, and wheat prices were sharply higher than the previous 5-year average. Broiler prices jumped 10 percent, while egg prices surged 25 percent. The combination of consumers favoring poultry over beef and the declining dollar could cause poultry receipts to rise 7 percent in 2004. For the second consecutive year, receipts from crops and livestock will each exceed \$100 billion, with their total forecasted at \$215 billion—an increase of \$3 billion from 2003. Cash receipts for corn and soybeans may rise 16 percent. However, there are some notable exceptions to this general pattern. Beef producers may see their receipts drop about \$6 billion from 2003, due to the effects of a ban resulting from the discovery of BSE. Even so, beef receipts should remain higher than in 2002. Dairy receipts may remain roughly constant. This expectation reflects cow milk productivity gains, which will offset a smaller inventory of milking cows.

Agricultural Policy

Direct government payments are expected to total \$10.3 billion in 2004, down from 2003's estimated \$17.4 billion. Direct payments were larger in 2003 because the 2002 Farm Act stipulated that farmers were to receive crop payments from 2002, 2003, and a portion of 2004 crop payments in 2003. Direct payment rates are fixed by legislation and are not affected by the level of program crop prices. Counter-cyclical payments, loan deficiency payments, and marketing loan gains in 2004 are expected to decline from 2003 levels. Market prices determine payment rates for these programs, and program crop prices are expected to be higher in 2004. In addition, the level of market prices relative to loan rates affects the amount of the program crop that realizes loan deficiency payments and marketing loan gains. The Crop Disaster Program, the Livestock Compensation Program, and Noninsured Assistance Programs are the only ad hoc and emergency programs expected to provide payments to producers in 2004.

Agricultural Trade

Exchange rates depreciated 10 percent in 2003, and a similar rate is forecast for 2004. This movement is expected to be beneficial for U.S. agricultural trade exports. U.S. agricultural exports are expected to be more competitive in world markets as the full effects of this depreciation are felt in 2004 and into 2005.

U.S. agricultural exports are forecast to rise to \$59 billion in 2004, a \$2.8-billion rise over 2003. Stronger prices and reduced export competition for corn and wheat, higher soybean and horticultural exports, and depreciation of the U.S. dollar largely offset reduced beef and cattle exports. Forecast exports for corn, wheat, and soybeans and horticultural exports are all higher. Larger wheat and wheat flour exports reflect strong foreign demand, particularly in Russia and Ukraine, where harvests were sharply reduced in 2003. Corn exports are also expected to rise in the face of higher prices stemming from strong domestic demand. Tight global supplies for oilseeds and their products are reflected in higher prices and a sharp increase in export value.

Meanwhile, U.S. horticultural products are expected to post the largest increase in several years. This expectation is predicated on a weaker dollar and expected improvement in the overall global economy. In particular, demand for California oranges is strong, and Florida's larger orange and grapefruit crops support increased sales. Gains in U.S. exports of fruits and foods to Canada are likely, reflecting depreciation of the U.S. dollar against the Canadian dollar.

As noted above, U.S. beef exports are expected to drop sharply. Most importing countries, including the top markets (Japan, South Korea, and Mexico) banned beef imports due to the U.S. case of BSE. Trade restrictions were imposed by more than 70 countries following the discovery of the U.S. case. These declines are offset by higher grain prices, decreased foreign grain competition, and depreciation of the U.S. dollar, which help boost U.S. agricultural exports to all markets—including those that have banned U.S. beef. Moreover, the value of pork exports is expected to rise, reflecting higher shipments and stronger prices. Higher pork demand reflects its status as a substitute for U.S. beef, which is currently unavailable in many countries.

Imports into the U.S. reflect many of the demand trends discussed earlier. For example, higher import demand for grain products—breads, pasta, flour, cereals, and dough—are expected to produce a 10-percent increase in import value in 2004. These products help meet increasing demand for high-value, ready-to-eat, prepared foods. Meanwhile, imported horticultural products (which comprise about 45 percent of total U.S. import value) are expected to increase in response to the expected stronger U.S. economy and a larger population. Imports of fresh and frozen produce are expected to rise \$500 million in the coming year. Fresh fruits and vegetables account for 36 percent of total U.S. horticulture imports. Mexico is the largest supplier of these foods to the United States. Imports of confectionery and sugar products are filling U.S. demand for candy, syrups, and sweeteners. Canada, Mexico, and the European Union are major sources of these products. Imports in this category are expected to rise \$200 million in 2004. On the other hand, cattle imports are expected to be drastically reduced in 2004, reflecting the 2003 Canadian BSE incident.

The U.S. is expected to remain a net food and agricultural exporter in 2004, consistent with the trend of the last few years. The U.S. has remained a net food and agricultural exporter due to its natural comparative advantage in producing such crops as oilseeds and grains. The U.S. enjoys a cost advantage due to abundant land resources and a favorable capital-to-labor ratio that allows the U.S. to produce these crops at a comparative advantage to other countries.

Infrastructure and the Food and Agricultural Economy

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Infrastructure, defined literally, is structure that is out of view. The most obvious examples are underground gas, power, water, and sewer lines along with telecommunications, including satellite, telephone, and cable. A broader definition incorporates the transportation system. While some of this network of roads, rails, waterways, cables, and pipes may be visible, most people only see a small fraction of it. Despite its relative lack of visibility, the economic benefits of infrastructure are considerable. Thus it is appropriate to assess the extent of the nation's infrastructure. Is capacity sufficient relative to demand? And how does infrastructure affect the U.S. economy and its food and agriculture?

We examine these questions by looking separately at four types of infrastructure: transportation, telecommunication, electricity and natural gas, and water and sewer systems. Transportation is emphasized because of its importance to food and agriculture. In addition to the extent and condition of physical infrastructure, we discuss infrastructure access and some important regulatory issues affecting infrastructure use. Where possible, the focus is on rural America and the connection between infrastructure, agriculture, and the food distribution system. We conclude with a statistical analysis of the contribution infrastructure makes to U.S. food processing industries.

TRANSPORTATION

The U.S. transportation system plays an important role in the nation's food and agricultural sector. By facilitating the movement of bulky commodities over long distances, the nation's transportation infrastructure provides U.S. farmers with ready access to a global marketplace. The ability to rapidly transport highly perishable, high-value food products has also allowed U.S. manufacturers to readily market their products overseas. This flexibility is a hallmark of the U.S. transportation system and has contributed to the high level of productivity in the country's agricultural sector.

Transportation Usage by the Food and Agricultural Sectors—The U.S. food sector relies heavily on the nation's transportation network, accounting for 11 percent of total freight shipments (measured by ton-miles) (U.S. Department of Agriculture, 2000). When combined with other agricultural shipments, food and agriculture (raw agricultural commodities, processed agricultural products, and farm inputs) is the largest single user of freight transportation in the nation, accounting for almost one-third of all freight transportation shipments in the United States.

The reasons for this heavy reliance on transportation are varied. Typically, agricultural production occurs in parts of the country that are far removed from areas of final demand, and many production areas are geographically dispersed over wide regions. The diversity of the U.S. food distribution system also means that agricultural commodities and products typically rely on a wide range of different transportation services or modes. For example, bulky and low-value products, such as grains, can often be shipped more cost-effectively over longer distances by slow-moving barges, while higher value, more perishable

products, such as fresh fruits, vegetables, and meats, are usually transported by trucks; other agricultural commodities, such as livestock, require specialized transportation services. Also, the input-intensive nature of modern commercial U.S. agriculture means that a wide variety of products, such as fertilizers or feed additives, must be shipped using transportation services adapted to individual needs.

Overall, trucks are the most important mode for shipping food products, accounting for nearly two-thirds of all such shipments (as measured by ton-miles). Railroads account for about a quarter of all goods shipped, multiple transportation modes account for 7 percent of goods shipped, and barges transport less than 2 percent of products. Trucks are dominant in the shipping of meat and poultry, dairy products, canned or preserved foods, bakery products, confectionery products, beverages, and miscellaneous food products (Table 1). Railroads are most important in moving grain mill products. Sugar, beet, or cane goods are moved using multiple modes. Air transport remains an important mode for moving high-value agricultural products, such as horticultural goods, berries, and early-harvested stone fruit (peaches, plums, cherries, and apricots).

Modal share for shipments of food and agricultural products (measured in percent ton-miles), 1993

Trucks are the most important mode for shipping food products

Commodity	Trucks	Railroads	Barges	Multiple modes	Total
Meat, poultry, fresh/frozen	86.6	10.3	-	3.1	100.0
Dairy products	89.6	7.1	-	3.3	100.0
Canned or preserved foods	72.6	21.2	-	6.2	100.0
Grain mill products	46.1	47.8	2.7	3.3	100.0
Bakery products	90.4	2.1	-	7.5	100.0
Sugar, beet, or cane	22.2	30.8	-	47.1	100.0
Confectionery products	94.1	2.8	-	3.2	100.0
Beverages	68.0	21.0	3.0	8.0	100.0
Misc. food products	3.8	35.4	5.6	5.3	100.0
Other agricultural commodities	33.4	35.0	18.1	13.5	100.0
All food and agriculture	44.8	31.7	12.3	11.2	100.0

Note: Adapted from Table A1 (Appendix A), U.S. Department of Agriculture, *Agricultural Transportation Challenges for the 21st Century: A Framework for Discussion*, 2000.

Sources: U.S. Dept. of Transportation, Bureau of Transportation Statistics, Commodity Flow Survey, 1993 and a special farm-based transportation survey conducted by the Center for Transportation Analysis, Oak Ridge National Laboratory, *Integrated Airport Systems (NPLAS): 2001–2005*.

Effects of Transportation on Agriculture Over Time—With large segments of the nation's agricultural production taking place in the interior of the continent, transportation is a critical component in the U.S. food and agricultural sector in areas far removed from the ports that are used to transport commodities to overseas markets. The development of a wide-ranging inland waterway system (which is sustained through federal investment), an efficiently operating rail transportation network, and the world's most extensive road system have allowed U.S. agriculture to compete aggressively with foreign competitors. In contrast, while many other nations have areas of production located closer to ocean ports, they traditionally have been unable to compete as effectively with U.S. producers because their transportation and distribu-

tion systems are less efficient.

As the most productive agricultural system in the world, U.S. agriculture is not only exceedingly specialized but highly dependent on an advanced transportation system that incorporates all

different modes of movement (on highways, rail, water, and, to a lesser degree, air). The transportation system also has enabled residents of farm-producing regions to leave agricultural production regions and to move to cities in search of employment opportunities, which facilitated the expansion of manufacturing and related activities throughout the twentieth century.

Heavy reliance on the transportation network has also enabled agricultural production to take place in areas where resources and weather patterns are most conducive to their development. Hence, the development of refrigerated rail car and more efficient container refrigeration technologies enabled California and the Southwest U.S. to arise as major producers of fresh vegetables. And the development of long-haul trucks with refrigeration capabilities, coupled with the building of an extensive network of interstate highways, further allowed these areas to continue their domination of this market.

The efficiency of the U.S. transportation system has also encouraged the expansion of economies of scale in agricultural production. Increased competition among U.S. producers, domestic production areas, and foreign producers has encouraged the development of different products and has enhanced overall customer service. In turn, such competition has helped to prevent or reduce distortions in commodity prices and helped to bring about pricing discipline in U.S. agricultural markets.

THE STATE OF THE TRANSPORTATION NETWORK

Despite some notable improvements in recent years, questions have been raised about the U.S. transportation network. Major concerns primarily deal with quality and capacity issues.

Highways—The condition of U.S. roads generally improved between 1993 and 2001.¹ Improvement was most dramatic for rural interstate highways, with the percentage of interstates

in non-metro areas (measured in miles) rated in poor or mediocre condition decreasing from 35 percent in 1993 to 14 percent in 2001 (U.S. Department of Transportation, 2003). Urban areas saw similar, though less dramatic, increases in interstate highway quality during this period.

In spite of these gains, only 40 percent of all U.S. urban and rural roads were rated in either good or very good condition in 2001, while almost 19 percent were in poor or mediocre condition. Overall, rural roads are in better condition than those in urban areas. For example, while only 15 percent of rural roads (as measured by miles) were in poor or mediocre condition in 2001, some 28 percent of urban roads were so classified.

The condition of bridges in the U.S. also improved significantly during the 1990s. In 1991, approximately 40 percent of the nearly 600,000 roadway bridges in the nation were rated as either structurally

deficient (restricted or closed bridges that require immediate rehabilitation) or functionally obsolete (bridges that no longer meet current criteria for the particular roadway on which it is located). This compares to just 28 percent of bridges that were so rated in 2001.

However, in recent years, U.S. roads, especially those in urban areas, have been increasingly affected by congestion. A 2003 study examined roadway delay and congestion costs per person for 75 different urban areas of varying sizes and found that individuals lost 26 hours per year due to roadway slowdowns, which equates to \$517 on a per-person basis (Texas Transportation Institute, 2003). Delays are greatest in the largest urban areas—Los Angeles was rated as most congested—but they have been growing most rapidly in medium-sized urban areas. Delays increased by 4.3 percent annually (measured on an hourly basis) between 1991 and 2001 for all 75 urban areas studied.

Increased trade, heightened security measures, and expanded immigration have all increased demands on the nation's road network in recent years. Moreover, passage of the North American Free Trade Agreement (NAFTA) has led to growth in north-south highway traffic, as U.S. trade with Canada and Mexico has increased by 90 percent since 1994 (U.S. Department of Transportation, 2001). The capacity of the nation's highway system has not grown sufficiently to handle these increases in volume. Although vehicle-miles traveled increased by 80 percent between 1980 and 2000, lane-miles of public roads increased by only 2 percent during the same 20-year period (U.S. Department of Transportation, 2001). The result is increased congestion, particularly with regard to truck traffic.

Rail—Capacity issues have also affected the nation's rail freight system. Deregulation of the industry in 1980 provided major railroads more freedom to restructure their operations, and many companies boosted profits during the 1990s by holding down costs. Increases in efficiency were achieved through a number of high-profile mergers. While consolidations resulting from deregulation helped improve the overall economic health of the industry (at least in the short term), it also resulted in several high-profile service disruptions. The agriculture sector was among those industries most negatively affected by such slowdowns during the mid- to late-1990s.

In spite of efficiency gains achieved during the major consolidation phase of the 1990s, issues of quality and capacity continue to dominate the nation's rail network. A recent study discussed the aging rail infrastructure (track, cars, signal equipment) and the scarcity of investment capital necessary for new or improved rail stock needed to meet the major challenges facing the rail industry (I-95 Corridor Coalition, 2002). Over the last 20 years, traffic on the nation's railroads increased by 55 percent (as measured by ton-miles of freight). Despite this growth, national rail system mileage actually decreased during the same period, largely because of industry consolidations. The result has been that rail capacity has been severely strained in recent years. By one estimate, over \$6 billion in rail improvements will be needed in just the five-state Mid-Atlantic region if growing demands are to be met over the next 20 years (I-95 Corridor Coalition, 2002).

Waterways—In an era of sharply expanding global trade, maritime transportation in the U.S. is faced with a number of key challenges, including increased waterborne and landside (road and rail) congestion around ports, the tendency for larger containerized vessels to use U.S. port facilities, and evolving security needs. U.S. ports must improve existing terminal capacity and add new facilities, where needed. Dredging operations should also be expanded to maintain adequate depths for harbors and channels. And intermodal connections should be upgraded to ensure timely and reliable overall transportation service.

Likewise, U.S. inland waterways must deal with issues of quality stemming from increased traffic. The current state of disrepair of many of the nation's locks and dams, especially those located on the Mississippi-Illinois River system, which were largely built in the 1930s, must be addressed. Upgrading this infrastructure will be costly, and no consensus currently exists on how these costs will be met or how environmental concerns can be addressed. Also, resolving the competing claims (including agricultural, environmental, commercial, and recreational uses) on the Columbia-Snake River system in the Pacific Northwest will be difficult, given that no consensus currently exists on the best use of this waterway.

Future usage of the water transportation system may also be affected by external factors. For example, in recent years, a number of international competitors of U.S. grain markets (primarily in South America and East Asia) have undertaken significant improvements in their domestic transportation systems (Bertels, 1998). This development may make foreign agricultural producers more competitive, which could reduce demand for U.S. agricultural products. In turn, this may decrease waterborne traffic on America's inland waterways.

Air—Overall, U.S. airport runway pavement is in good condition. According to the Federal Aviation Administration, the percentage of runways at the nation's most important airports (commercial airports, reliever airports, and selected general aviation airports) rated in good condition increased from 61 percent to 73 percent between 1986 and 2000 (U.S. Federal Aviation Administration, 2002). During the same time period, the percentage of runways classified in poor condition at these airports decreased from 11 percent to 5 percent.

Despite these improvements, the nation's air traffic system faces problems associated with increased congestion and heightened security concerns. By one estimate, \$46 billion in air transportation infrastructure development will be needed to meet the needs of all aspects of civil aviation by 2007 (U.S. Federal Aviation Administration, 2002). Air cargo and passenger capacity is constrained by the limited availability of new landing slots at major commercial airports. Opposition to airport noise and the expansion of airport operating hours also pose limitations to the air system. Many shippers, including those of high-value food and agricultural products, are increasingly using air transportation services to meet just-in-time shipments. Therefore, constraints in the air cargo system, coupled with sharply higher passenger air traffic, pose challenges to the nation's transportation network.

THE POTENTIAL OF TECHNOLOGICAL IMPROVEMENTS

Various technological innovations may help alleviate some of the congestion- and safety-related problems of specific transportation modes, potentially improving efficiency of the overall network. For example, Intelligent Transportation Systems (ITS) utilize new transportation technologies to help balance heavy traffic loads, reduce commute times, and improve highway safety. The U.S. Department of Transportation notes that, "traffic management systems that use real-time traffic data to control intersection signal timing, freeway ramp metering, and alternative route information on dynamic message signs can improve journey times by 13 percent on heavily congested networks" (U.S. Department of Transportation, 2004). ITS technologies are also widely used in freight scheduling applications, facilitating just-in-time deliveries. For example, truck shipments are commonly tracked using global positioning system (GPS) and radio frequency identification (RFID) technologies. In maritime transportation, the use of larger oceangoing container vessels has brought about efficiencies in international trade, as has the development of refrigeration technologies that minimize onboard spoilage of fresh, perishable commodities. In rail freight transportation, the standardized use of larger "unit trains" (a string of rail cars that all carry the same product, usually over long distances) has resulted in cost efficiencies in the movement of many bulk commodities (including grain).⁴ And innovations in air freight scheduling technologies, working in concert with just-in-time production systems, have helped to improve product quality and reduce costs for high-end, highly perishable food and agricultural products.

TELECOMMUNICATIONS

Advanced telecommunication systems are becoming increasingly important for linking together the economy. Almost all Americans have access to telephones, but many still lack access to the newer, more advanced forms of telecommunication. The Internet, the most important form of advanced telecommunication, has expanded rapidly in recent years, with Internet usage growing from 22 percent of U.S. households in 1997 to 54 percent in 2001.² A 2003 survey found that Internet usage nationwide averaged 63 percent: 52 percent for rural residents and 67 percent for urban residents (Bell et al.).

Rural Internet Challenges—Significant urban-rural differences exist in terms of quality, cost, and ease of access. First, it generally costs more for Internet service providers to physically link up households in low-density areas than in high-density areas. With fewer potential customers in rural areas, profits are lower, so these regions are the last to be scheduled to receive service. Thus many rural areas have access only to federally subsidized Internet service at community centers, such as schools, libraries, and health facilities. In such cases, access is inconvenient for individuals, farms, and businesses compared with communities where home access is available. In addition, because the poor cannot afford personal computers and Internet service, rural Internet usage tends to be lower in the South, where incomes tend to be lower.

Where rural households and businesses have home access to the

Internet, they may have to pay more expensive long-distance rates for their phone connections, or they may have poorer quality connections than in urban areas, greatly diminishing their ability to use the Internet. Some federal programs provide funding for higher quality, high-speed connections (broadband) in rural areas, but this funding is limited.³

Use by Farmers and the Food Distribution System—According to a 2003 survey, nearly half (48 percent) of U.S. farm households now have Internet access, and the majority of these Internet-using farm households use it for the farm business (NASS).

Previous USDA research (using 2000 data) has shown that most farmers with Internet access have been using the Internet mainly to collect information to help manage the farm (Hopkins and Morehart). Only 11 percent of farm Internet users have been conducting e-commerce by buying and selling over the Internet, especially inputs. However, some producers are beginning to auction off their product using the Internet. Theory suggests small and remote farms might benefit most from this kind of Internet activity, since this might add to the number of suppliers and sellers they face and would therefore give them more bargaining power. However, farm Internet access is more common for large farms (72 percent) than for small farms (47 percent) (NASS). In addition, Internet use currently tends to be more common in urban and less remote places (Hopkins and Morehart).

Advanced telecommunications appear to have had a more significant impact, thus far, on the downstream links in the food distribution system. For example, modern inventory management systems are used by most of the larger food retailers in the United States, and these systems require the use of advanced telecommunications. The larger food manufacturing firms and major transporters of food and agricultural commodities are also heavy users of advanced telecommunications. This has reduced costs and lowered food prices, helping to keep U.S. food competitive in the global economy.

ENERGY

U.S. agriculture and food markets rely heavily on a sound energy infrastructure. Food processing industries rank fifth among the largest energy consumers among manufacturing industries, and farmers also rank high among energy consumers in local markets. Food industries depend on low cost and reliable energy for refrigeration, heating, cooling, lighting, packaging, and transportation, among other uses. Farmers rely on inexpensive fuel and electricity to operate machinery, vehicles, and irrigation systems and to keep down the costs of fertilizers and pesticides of which energy is a critical input. Energy infrastructure plays a large role in the health of the rural economy by fueling energy-intensive industries, supporting a variety of integrated business needs, and keeping distant areas connected.

Increasingly, farmers and food manufacturers are meeting their energy needs by investing in energy production and conservation. Among farmers, ethanol is the most prevalent of these new developments, but wind generation is also growing. Food manufacturers are

investing in cogeneration, other forms of on-site energy generation, and a wide array of energy conservation technologies. A robust energy infrastructure that allows for both consumption and production flows is critically important to rural industries.

The nation's energy infrastructure is in an important stage of transition, and this is particularly true for electricity infrastructure. Over the last two decades, the provision of electricity and natural gas has been transformed from a system of regulated monopolies into a more disaggregated, market-oriented structure. The transition to a market structure has been relatively smooth for natural gas, but it has been more complicated for electricity. Electricity cannot be stored, and the supply and demand of electricity must always be in balance. Therefore, electricity requires a high level of system management and coordination. Introducing market mechanisms has proved more difficult than anticipated, as demonstrated in California electricity markets during 2000–2001. The current configuration of electricity markets is a regional mix of old and new structures, but there is significant debate about how best to organize electricity markets at the national level.

The most important area of discussion concerns whether the states or the federal government should have ultimate authority over transmission facilities (the “grid”). Currently, the grid is managed by regional system operators with cooperation from market participants and oversight by both federal and state regulators. But because of the transitional nature of the system and the uncertainty surrounding its management, investment in transmission facilities has been declining. The market-oriented structure, which is fully in place in wholesale electricity markets, has put added stress on networks because of significantly higher levels of buying and selling activity. A major blackout occurred in the Northeast and Midwest (and Canada) in August 2001, largely as a result of management failure. Transmission management, investment, and jurisdiction are the priority issues in energy infrastructure to be resolved in the near term.

Reliability of the electricity supply is crucial to rural areas and to the food industry. Along with primary metals and chemicals industries, food processing industries are considered the most vulnerable in the United States to electricity supply disruptions. In a recent study by an industry group called the Electric Power Research Institute (EPRI), these three industry groups (food, metals, and chemicals) have the highest combined economic intensity (as measured by high value added per employee) and electricity intensity (as measured by electricity consumption per unit value added). EPRI lists 12 food, beverage, and tobacco industries, two agricultural pesticide and fertilizer industries, and two wood/paper industries among the 43 most vulnerable industries.

Natural gas deregulation, on the other hand, has been very successful. Once considered a declining resource, production has increased in the last two decades and the increases have been attributed to the deregulation of natural gas markets. Natural gas is now the fastest-growing fuel, and it has been especially important in fueling low-cost electricity generation. Deliverability of natural gas is a major bottleneck, however, and most regions in the U.S. are seeking to expand

their pipeline capacity.

The critical energy infrastructure needs of the United States are in natural gas and electricity delivery systems. With rapidly growing electricity and natural gas demands, the rapid resolution of these infrastructure issues is essential, especially for U.S. agriculture and food markets.

WATER

In this section, we discuss three types of water infrastructure: (1) safe drinking water, (2) “clean water” treatment of wastewater, and (3) agricultural irrigation. Safe drinking water is critical for good health. Wastewater treatment helps keep the nation’s rivers, lakes, and coastal areas clean, which is important for both recreation and the environment. Irrigation is important for agricultural uses, including both crops and livestock. The food industry, including food processing, also makes extensive use of water infrastructure. For example, the soft drink industry is one of the big users of drinking water.

Water infrastructure is also important for local economic development, providing for new residents and businesses. An ERS analysis (Bagi, 2002) of data from an Economic Development Administration (EDA) study shows that rural communities derived sizeable economic benefits from local water and sewer projects, including increased employment, private investment, and property tax base.

The Growing Cost of Making Water Safe and Clean—Congress passed the Clean Water Act (CWA) in 1972 and the Safe Drinking Water Act (SDWA) in 1974. Both have been subsequently amended to expand the level of public health protection. The CWA sets standards that household and industrial wastewater (excluding agricultural production) should meet before being released into streams, rivers, lakes, or coastal waters. It applies to more than 16,000 publicly owned wastewater treatment plants. The SDWA applies to more than 180,000 public water systems. Since the passage of these laws, the nation has invested hundreds of billions of dollars to upgrade and protect water quality.

Despite substantial improvements in water quality over time, more work is needed to improve water quality in the United States. Both the public and private sectors pay the cost of maintaining and improving water quality. The Environmental Protection Agency (EPA) estimates that in 1998 the annual cost of pollution control and prevention to the private sector was \$30 billion, plus \$0.5 billion by agriculture to control the effects of nonpoint source runoff. In the same year, the public sector spent \$33.5 billion, including \$23 billion by municipalities on their water and wastewater infrastructure, \$0.5 billion by the states, and \$10 billion by the federal government (EPA’s National Water Quality Inventory, 2000).

EPA has recently estimated that building new drinking water systems and upgrading existing ones from 2000 to 2019 would require \$263 billion, including \$102 billion in capital investment and \$161 billion in operating and maintenance funds. Over the same 20-year period, new and improved wastewater treatment facilities will require \$271 billion, including \$122 billion in capital investment and \$148

billion in operating and maintenance funds. The cost of building, maintaining, and upgrading water systems that comply with all pertinent regulations is too high for many small towns to finance alone. Therefore, many rural communities rely on federal aid to finance the construction of new water and wastewater systems or improvements to existing systems.

About 90 percent of water pollution is caused by runoff from farms, feedlots, forestry operations, construction sites, urban streets, and suburban lawns. Agricultural runoff remains a major source of water pollution across the country. The runoff may include fertilizers, chemicals, pesticides, insecticides, animal and human waste, silt, bacteria, metals (mostly mercury), and oxygen-depleting substances. New proposed regulations would require states to revise their procedures for monitoring and reducing water pollution to focus on the most pressing causes of that pollution, including agricultural runoff.

Irrigation Infrastructure—Agriculture accounts for about 80 percent of U.S. water use and more than 90 percent of water use in many Western states. In 1997, over 55 million acres of crop and pasture land were irrigated. Four of every five irrigated acres are located in the Western states (This section on irrigation draws on ERS’s Agricultural Resources and Environmental Indicators, 2003).

Irrigation greatly improves the value of crop sales. Irrigated harvested cropland accounts for only 16 percent of cropland in the nation, but almost half of the total value of crop sales in 1997. Irrigated cropland acreage is led by grain and forage crops. The crops most dependent on irrigation are rice, orchards, Irish potatoes, vegetables, and cotton.

Irrigation infrastructure varies with the source of water. Surface water accounted for 63 percent of total irrigation water in 1990, with groundwater supplying the remaining 37 percent. However, the proportions vary by region. In the West, two-thirds of all water withdrawals for irrigation are diversions (dams and canals) from streams, rivers, and lakes. In the East, over 70 percent of water withdrawals for irrigation come from groundwater aquifers.

In the case of groundwater irrigation, the water is withdrawn with pumps from wells drilled into underground aquifers. Over half of the nation’s irrigation wells are concentrated in 4 states: Texas, California, Nebraska, and Arkansas. The aquifer itself may be viewed as nature’s own contribution to this groundwater infrastructure. When withdrawals exceed natural rates of recharge, water reserves are reduced, the aquifer composition is damaged, and pumping costs rise. This “overdrafting” problem is perhaps best known with the Ogallala Aquifer in the Great Plains, but overdrafting has also occurred in the Southwest, Pacific Northwest, Mississippi Delta, and the Southeast.

The infrastructure associated with surface water irrigation consists primarily of dams and water distribution systems. Many of these were financed by the federal government; some were built during the Great Depression. As this infrastructure ages, decisions must be made concerning its future. In some cases, dams have been removed in response to environmental concerns. For those that remain, particularly those in the Southwest and Far West, agricultural users must compete with

increasing demands coming from urban growth and recreation. Given the limited surface water available, this may result in declining availability for irrigation in these places. Farmers are likely to shift production to high-value crops and away from low-value crops when facing higher irrigation water rates or charges.

A Comparison of Food and Nonfood Industries' Use of Infrastructure

Data from the input-output tables of the 1997 Census (the most recent available) illustrate the extent to which food and nonfood industries use infrastructure services (per dollar of expenditures and per dollar of exports) to process, manufacture, and distribute raw commodities for domestic consumption and for exports.

Overall, the food industry uses more infrastructure per dollar of domestic consumption than does the nonfood sector. To meet the export demand in 1997, the food industry used \$0.38 infrastructure services per dollar of exports. Transportation services were the largest components of food processing infrastructure services and were used more intensively by the food industry than nonfood industries. Trucking dominated transportation infrastructure services for the food industry, comprising about two-thirds of this segment. The relatively high need for transportation services reflects the large distances between farms and processing plants, and the special handling needed for perishable farm commodities. These estimates reflect the crucial role transportation services play in the food production process. Meanwhile, electricity comprised the largest component of the utility sector. Electricity is the predominant source of energy used in the food industry, reflecting the widespread use of coolers and freezers for food preservation. Nevertheless, the food industry uses electricity less intensively than the nonfood sector. However, IT infrastructure services were relatively new in 1997. IT infrastructure *services per dollar of food expenditures* were very small that year and came to only \$0.01.

The relative proportions of wholesale and retail trade requirements differ greatly from their domestic counterparts. While retail services account for more than half of the aggregate domestic food trade margin, wholesale services comprise nearly all the corresponding export trade margin. This result reflects the lower number of distribution points required to move food from U.S. farmers to final foreign consumers.

Infrastructure Services Used by the Food Industry in 1997				
	Domestic Food Expenditure	Food Exports	Nonfood Personal Consumption Expenditures	Nonfood Exports
<i>Percent of dollar value</i>				
Transportation	0.0584>	0.1067>	0.0411	0.0945
Truck	0.0385>	0.0721>	0.0155	0.0345
Rail	0.0081>	0.0193>	0.0034	0.0095
Air	0.0080<	0.0089<	0.0163	0.0384
Water	0.0011<	0.0021<	0.0018	0.0085
Utilities	0.0267<	0.0327>	0.0415	0.0210
Electricity	0.0213<	0.0243>	0.0323	0.0163
Natural Gas	0.0051<	0.0078>	0.0082	0.0045
Water, Sewer, etc.	0.0003<	0.0005>	0.0010	0.0002
IT	0.0205<	0.0236<	0.0402	0.3005
Computers	0.0120<	0.0139<	0.0224	0.1559
Software & Data Services	0.0072<	0.0083<	0.0110	0.1052
Semiconductors	0.0013<	0.0014<	0.0068	0.0394
Wholesale Trade	0.1471>	0.2140>	0.0701	0.1380
Retail Trade	0.1714>	0.0064>	0.1082	0.0038
Total	0.4156>	0.3737<	0.2833	0.4131

¹ The Federal Highway Administration introduced a new indicator for pavement condition in 1993. Therefore, comparisons between pre-1993 and post-1993 highway condition data are inappropriate.

² Most of the information presented here on telecommunications was drawn from the Rural Telecommunications briefing room and from the Agribusiness/Industry Concentration key topic (e-commerce subtopic); both can be found on the Economic Research Service website: www.usda.ers.gov.

³ For a good discussion of the rural Internet situation, including the reasons for higher rural costs and slower diffusion, as well as how federal policy facilitates diffusion, see Stenberg.