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# The Role of California and Western US Dairy and Forage Crop Industries in Asian Dairy Markets

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## Abstract

California's dairy and the closely linked forage crop industries developed a remarkable record of growth and success until about a decade ago when growth slowed dramatically. California's dairy farms and processing plants still account for about 20% of US milk production and almost 40% of US dairy exports. California alfalfa and other hay account for about 30% of production among states west of the Rocky Mountains. Continued population and income growth is projected to expand the demand for dairy products in Asia. California can play a crucial role in meeting this demand if it can maintain competitiveness in milk production and processing.

**Keywords:** exports, dairy, forage, alfalfa hay, Asian demand, California

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## Introduction

The dairy industry in California and the closely linked forage crop industries grew remarkably for three decades through 2007 after which output has been stagnant (Sumner 2014). California accounts for about 20% of US milk production and almost 40% of US dairy product exports. Milk production is supported by a forage crop industry within California and in other Western states. The seven states west of the Rocky Mountains produce 31.5% of US alfalfa hay (USDA-NASS). The supply of high-quality forage and presence of favorable climatic conditions for maintaining dairy cattle are leading factors in California's and Western US states' ability to supply both processed dairy products and forage inputs to meet expanding dairy demand in Asia.

This article focuses on long-term developments in export markets, but a number of current events and recent developments warrant attention. California was in a historic drought that has lingering consequences despite above normal precipitation for the 2015/16 water year (Howitt et al. 2015). Despite the drought, milk production rose with high milk prices in 2014 and fell by 3% in 2015 as cow numbers fell by about 2% (CDFA 2016). The irrigation situation is one more factor limiting the expansion of dairy supply from California as local hay and silage acreage must compete for water with tree nuts, which have expanded acreage rapidly in recent years. The collapse in tree nut prices in late 2015 and 2016 may put a damper on expansion in tree nut plantings, but as more active markets allow water to be allocated across uses based on potential profitability, forage crops will face stiffer competition.

Dairy policy may change if the California milk marketing order is replaced by a federal order. That proposal awaits USDA response and is likely several years from reality even if it is eventually approved by producers. A potential shift to a federal marketing order has no mechanism for supply control. A different government pricing policy across dairy products could affect the regulated minimum prices for farmers and the distribution of product mix somewhat. This article does not include projections of the impact of changes in the details of the California pricing system.

Other current issues facing California dairy include concerns about access to hired farm labor and environmental regulations on farms and processors. Water quality and air quality issues limit expansion of dairy production in the Central Valley, where most of the dairy industry is located. Potential subsidies for manure handling may add to dairy revenue and allow shifts in manure handling (Lee and Sumner 2014).

This article examines trends in dairy product consumption in Asia and the potential for continued growth in demand into the future. In addition, export data will show the role of dairy products and hay shipped from western ports in supplying Asian markets. We offer data and some ideas about future market developments. The major policy development that may affect trade relations in the region is the Transpacific Partnership (TPP) agreement which has been signed but not ratified or implemented. We do not include analysis of the implications of the TPP here because it excludes major markets (Korea and China for example), and the dairy provisions are small at best (Sumner, Lee and Matthews 2015).

## Asian Dairy Market Developments

Growth in dairy consumption in emerging markets depends on growth in population, urbanization, and per capita income. Of course, long-standing historical and cultural factors affect consumption

 

patterns, and these may also evolve slowly over time. For example, at each income level, populations with European heritage or influence have higher, and East Asians have lower, per capita dairy consumption (FAOSTAT 2016).

As the population grows slowly and per capita incomes rise more rapidly, Asian consumption of dairy products is increasing. USDA projects that the demand for processed dairy products is especially likely to expand rapidly in Asian markets (USDA–ERS 2013). Along with cultural shifts, changes in population and income are expected to contribute to changes in demand for dairy products for the region.

*Population Growth*

Populations are projected to grow among developing countries in Asia and shrink in Japan and Korea over the next fifteen years. Demographic projections use assumptions related to sex ratios and mortality in addition to assumptions about events such as war, famine and natural disasters (US Census 2013).

China, a large destination for US forage and dairy products, projects slight population growth over the next decade, then a gradual leveling off toward 2026 ending the 2020's with a slight decline (Figure 1). With shrinking populations in the wealthy countries of Japan and South Korea, the main area of population growth will almost exclusively be in developing countries such as Malaysia and Philippines, with slightly smaller growth in Indonesia and Vietnam. These high-growth developing countries are not now the main Asian markets for dairy and forage product exports, but between now and 2030 the pending population growth will expand the market potential substantially.

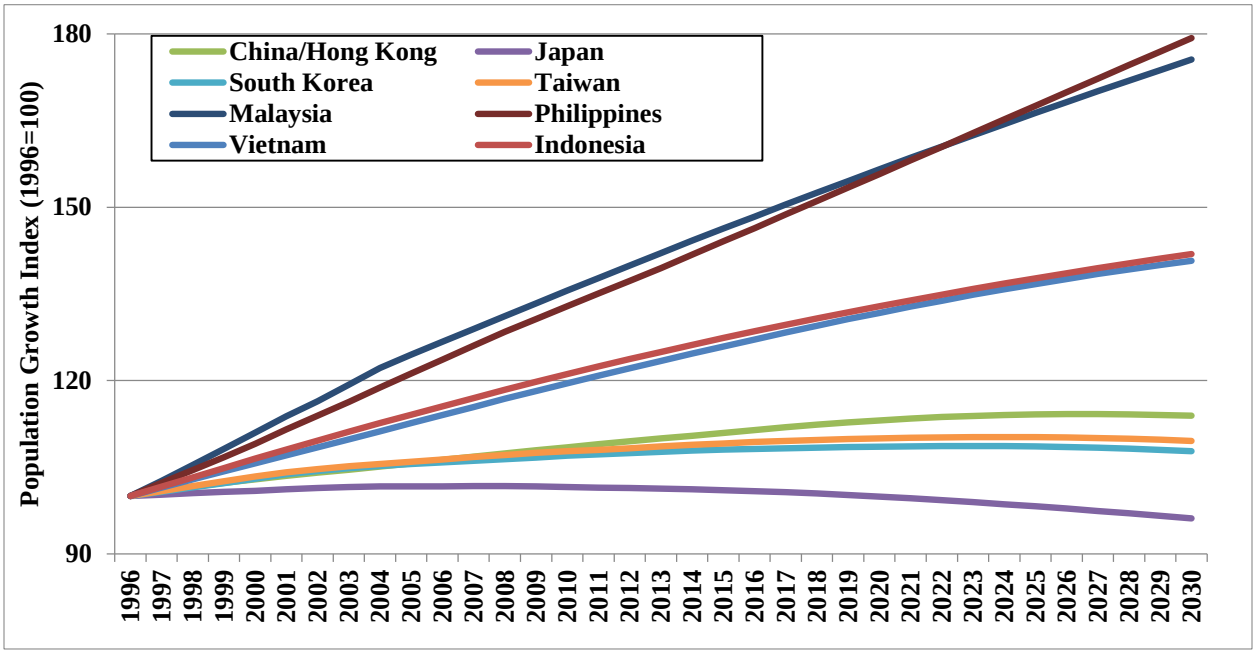


**Figure 1**. Past, current and projected future population of major Asian destination countries for US forage crop and dairy product exports, 1996–2030.
**Source**. U.S. Department of Commerce, Census Bureau

 

*Changes in Per Capita Income*

For dairy demand, it is especially crucial that many developing countries are reaching income levels at which they demand diet improvement, not just more food. For most people, diet improvement means more consumption of livestock protein products, including dairy products. Along with population, per capita income growth occurred both globally and in Asia over the past couple of decades in many of the large countries of Asia. In spite of declines in the rate of growth in 2015 (World Bank 2015), personal income is expected to keep increasing over the next fifteen years (USDA–ERS) (Table 1).

**Table 1**. Real per capita GDP by decade (base year = 2005).

| Region/Country | 1991–2000 | 2001–2010 | 2011–2020 | 2021–2030 |
|---|---|---|---|---|
| World | $6,077 | $7,170 | $8,311 | $10,419 |
| Asia | $2,462 | $3,166 | $4,484 | $6,524 |
| China | $804 | $1,936 | $4,321 | $8,187 |
| Indonesia | $1,045 | $1,291 | $2,049 | $3,173 |
| Malaysia | $4,157 | $5,387 | $7,247 | $10,042 |
| Philippines | $962 | $1,158 | $1,564 | $2,128 |
| Vietnam | $369 | $653 | $1,099 | $1,903 |

**Source**. USDA Economic Research Service, International Macroeconomic Data Set.

From 1990 to 2010 China experienced per capita income growth at an annual rate of greater than 9%. With 2005 as the baseline, real per capita income in China was about $715 in 1990 and grew to about $5,661 per capita in 2013. Income in China is expected to continue to grow in the next two decades but at a slower rate (World Bank 2015). In the decade of the 2020's projected per capita income will grow annually at an average of over 6% and decline to a rate of 5% growth per year the following decade. Much of this growth in income is attributed to a large migration of the Chinese population away from the rural countryside toward urban areas where higher paying jobs in manufacturing are found. Increased urban living often leads to adopting a diet more like that of Europe and the United States, again including more dairy consumption.

Although not as dramatic as in China, per capita incomes also increased over the decades in other large Asian countries such as Malaysia, Philippines, and Vietnam. Residents of these countries are projected to continue increasing their incomes from now through 2030 (Figure 2).

The increase in per capita income in Asia since 2000 has coincided with improved diets and increases in the per capita consumption of animal products. Since the mid-1970's per capita consumption in China, Japan, Korea, Malaysia, Philippines, Taiwan and Vietnam, the largest destinations for US forage and dairy exports in the region, has increased among all animal protein sources (Figure 3). The largest increase in consumption of animal-based protein is pork, beef and poultry meat products (UN FAOSTAT).

Dairy consumption increased gradually from the early 1960's to mid-1990's (Figure 4). Since 1997, the rapid expansion of the Chinese economy coincides with a large increase in per capita dairy consumption. The same yet less steady increases occurred in Vietnam. During the 35-year-period from 1960 to 1995, per capita, dairy protein intake in Asia-Pacific increased about one gram. In the sixteen years from 1997 to 2013, per capita dairy protein intake increased by almost two grams.

 

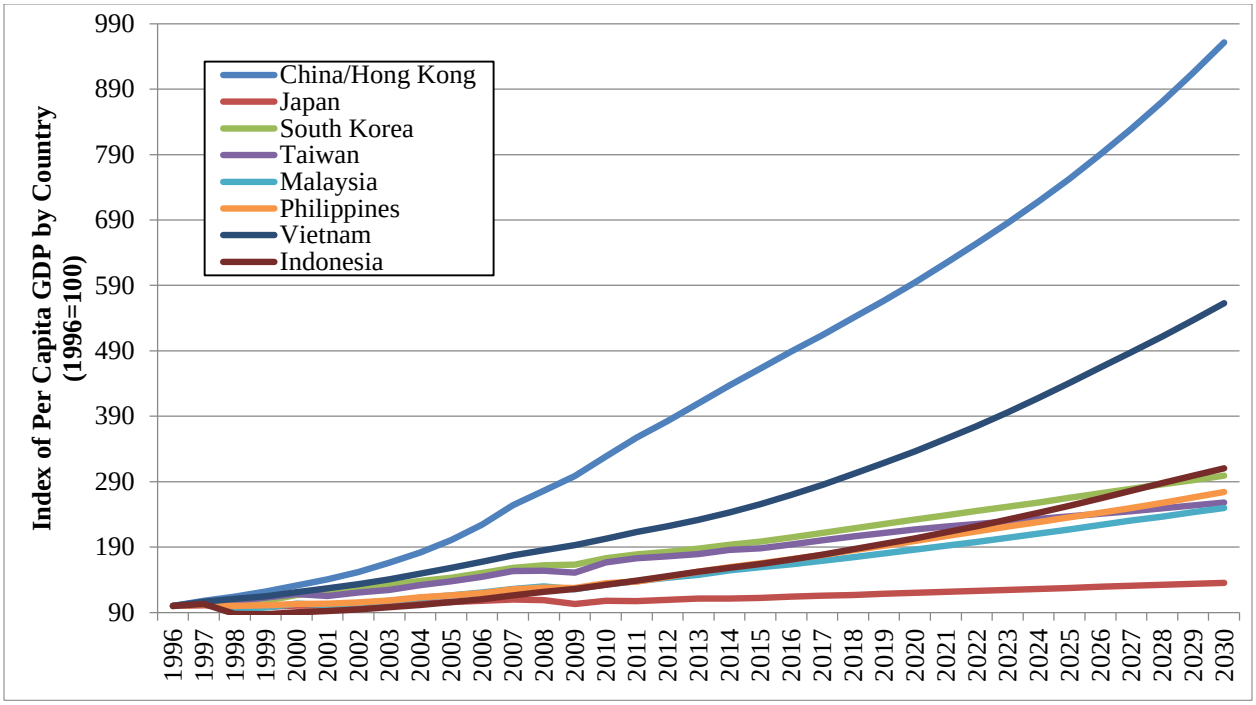


**Figure 2**. Index of real per capita GDP for major Asian destination countries for US forage and dairy product exports, 1996–2040.

**Source**: USDA-Economic Research Service, International Macroeconomic Data Set.

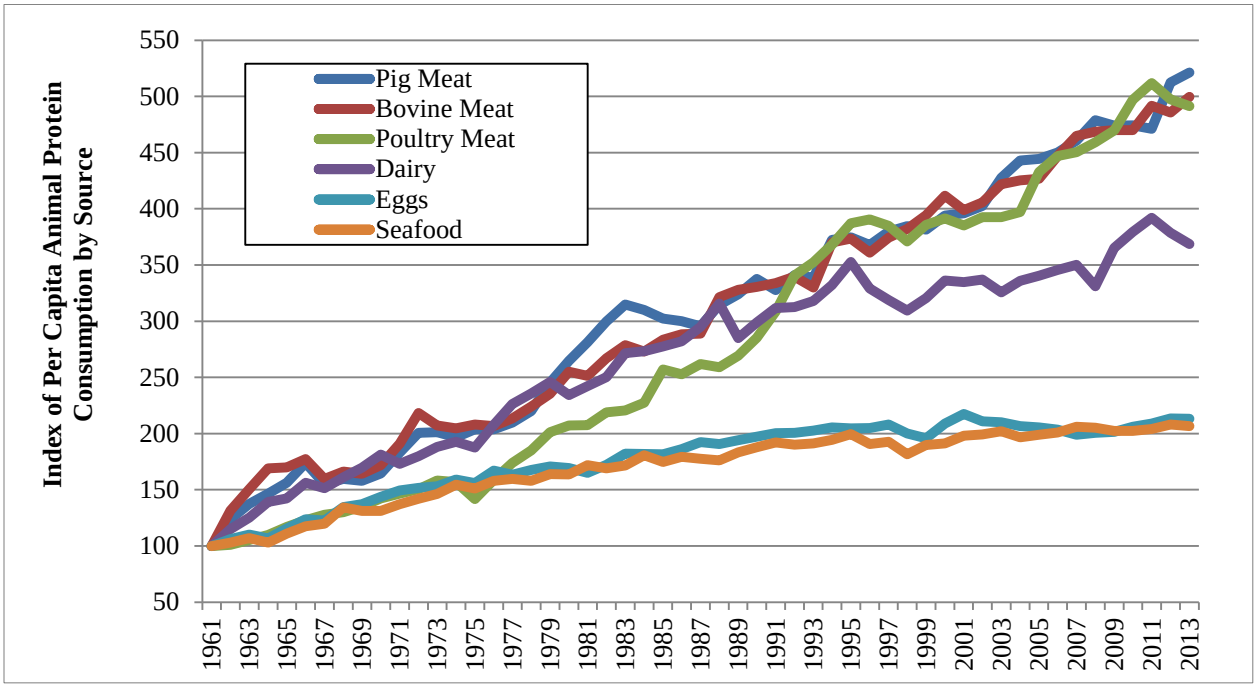


**Figure 3**. Index of animal protein consumed per capita, per day, by source in major Asian destination countries for US forage and dairy product exports, 1961–2013.

**Source**. UN FAO Statistical Database

 

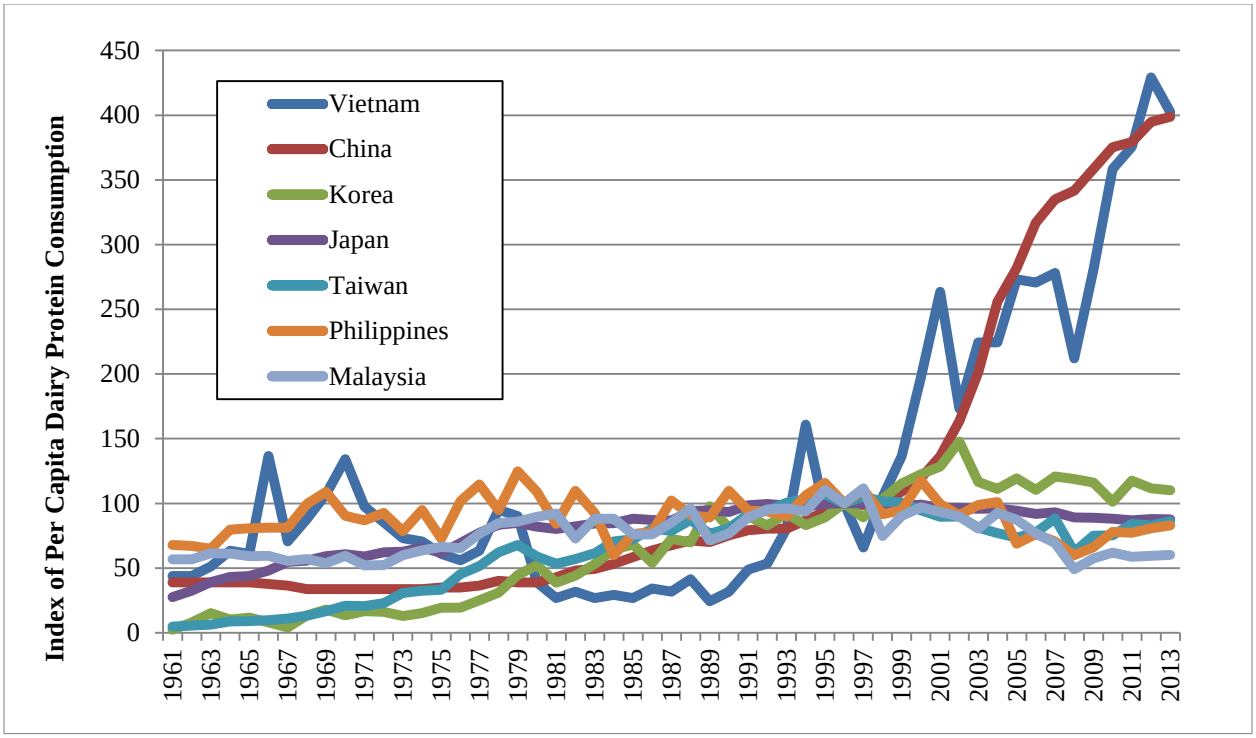


**Figure 4.** Index of dairy protein consumed per capita, per day in major Asian destination countries for US forage and dairy product exports, 1961–2013 (1996=100).
**Source**: UN FAO Statistical Database

## Western US Agriculture's Role in Meeting Dairy Market Demand in Asia

The rapid expansion in demand for dairy products since the early 2000's is a challenge for China's domestic producers. China has aggressively expanded their domestic dairy herd and domestic milk production, mostly to fulfill fluid milk demand, and there was a dramatic increase in the volume of dairy product imports (Li and Frederick 2015). Examining the China situation demonstrates how the California dairy and Western US forage crop industries can benefit from opportunities presented by growth in dairy demand throughout Asia.

*Expansion of Asia/Pacific Domestic Dairy Herd*

Aided by government support programs, China has increased the size of the domestic dairy herd from just over 2 million head in 2000 to around 8.5 million head in 2015 (Figure 5). Small farms are exiting making way for larger dairy farms (Li and Frederick 2015).

These changes involve imports of live dairy cattle from locations such as Australia, New Zealand, and Uruguay to improve genetics in China's domestic dairy herd (Li and Frederick 2015). In 2014, over 196,000 head of live dairy cattle were imported. In addition to imported cattle, China's Ministry of Agriculture continues to subsidize an ongoing dairy-breeding program for producers to improve domestic dairy herd breeding stock (Li and Frederick 2015). This subsidy provides semen doses for approximately 8.4 million breeding cows (Li and Frederick 2015). Although improved genetics increased milk productivity slightly, China still lags in yields per cow compared to the leading dairy producing countries (Li and Frederick 2015) (Figure 6).

 

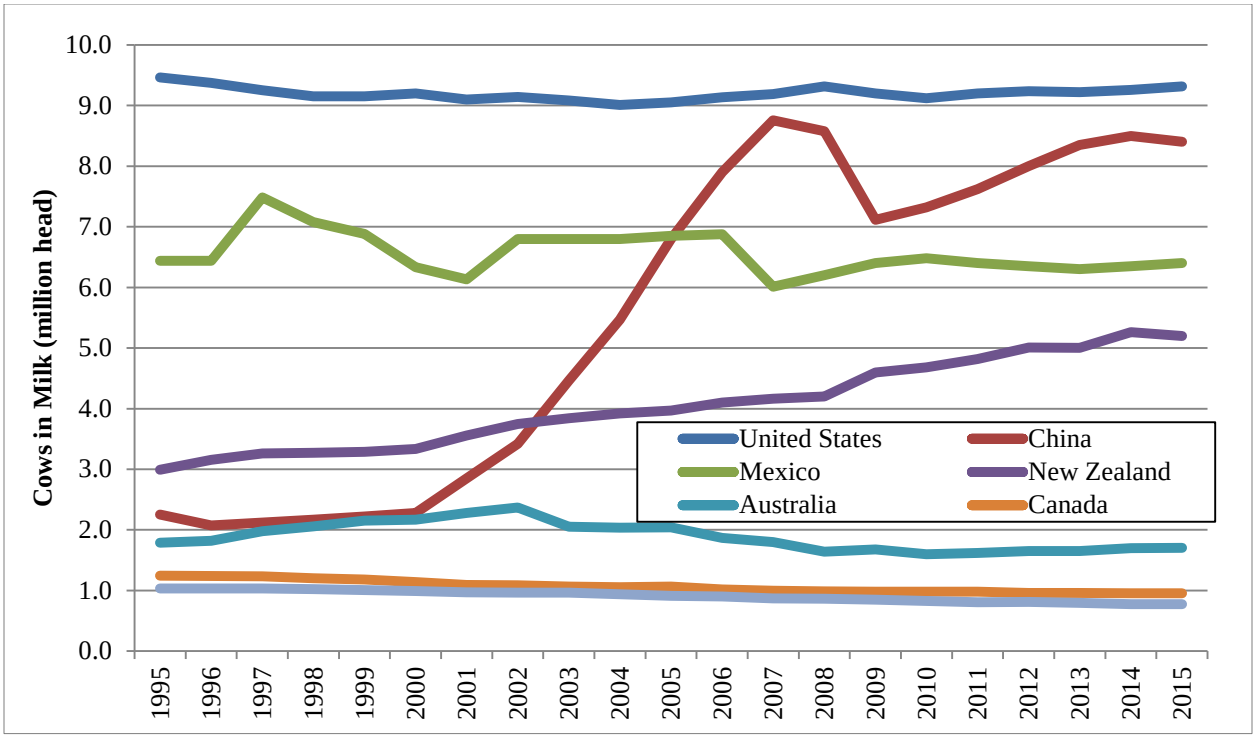


**Figure 5. S**ize of dairy herd in leading dairy countries (1995–2015)
**Source**: USDA Foreign Agricultural Service's PSD Database

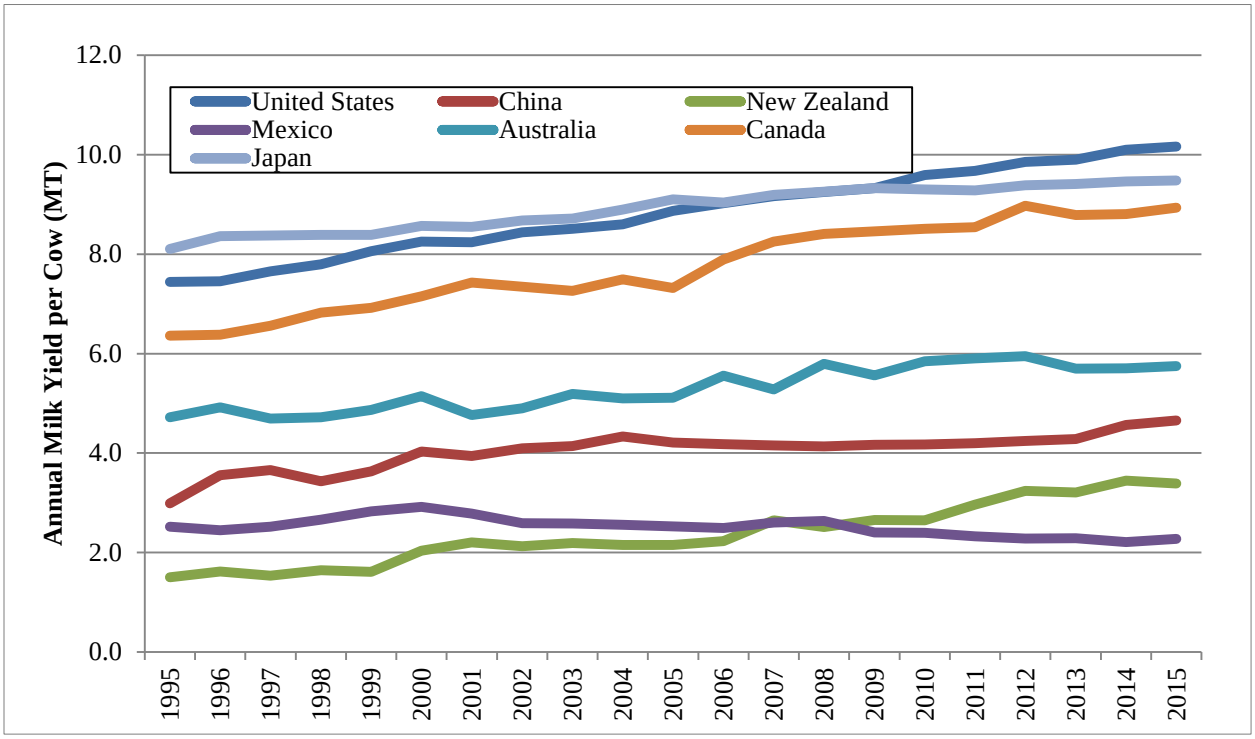


**Figure 6**. Annual milk yields per cow by country, 1995-2015. (USDA FAS 2015)
**Source**: USDA Foreign Agricultural Service's PSD Database

 

*Increased Demand for Quality Forage Crops*

A major challenge facing China, and other land-scarce Asian countries, is access to high-quality forage for dairy cattle (Zhu et. al. 2013; Wang, 2011). This is a necessary input to complement improved cow genetics and increase productivity while reducing costs (Li and Frederick 2015). Although dairy cows are fed many types of plant products, from a nutritional perspective, feeds provide a range of specific functional nutrients (Putnam 2008). Both grassy hays and alfalfa hays have been exported in large quantities, but alfalfa dominates the large emerging dairy markets in China and other Asian countries (Putnam et al. 2013, Putnam et al. 2016).

Forages deliver several important components in modern dairy cow rations:

- Energy—the ability to supply energy available per unit dry matter, released either directly (starches, sugars) or through ruminant fermentation.
- Intake—the ability of a forage to rapidly (but not too rapidly) degrade to yield energy and protein.
- Protein—the ability to supply both rumen available and rumen by-pass protein to be effectively absorbed by the animal.
- Fiber (NDF)—the functionality of fiber to enable proper rumen function, microbial health, pH stabilization, and salivation, and animal health.
- Minerals—provision of the proper mineral balance.

While many types of feeds supply several of these attributes of importance for dairy cow nutrition, not all feeds supply all nutrients, which is why mixtures of different feedstuffs are the norm to balance modern rations. The forage component of most modern dairy diets is dominated by a combination of corn or sorghum silage and alfalfa hay, with other forages (miscellaneous grasses) playing an important role in some cases. Forages are typically 45–60% of diets, with grains and protein supplements typically making up the remainder of the ration.

Dairy cows require NDF at a minimum level, and that NDF (fiber) must be digestible. Functional fiber is probably the unique quality provided by alfalfa and hay that cannot be provided by other feedstuffs such as grains or corn silage. However, high-quality forages such as dairy-quality alfalfa hay provide a combination of digestible energy, high intake, protein, and effective fiber, which results in high levels of milk production, and thus is highly prized by dairy nutritionists. Producers formulate feed rations for ruminant animals in general, and specifically for dairy cattle, to provide adequate quantities of crude protein, energy or net energy for lactation in dairy cattle and long fiber.

China and other Asian countries face several limits on their ability to domestically produce high quality forages such as alfalfa.

- **Access to Water Where Climate is Suitable.** Adequate rainfall or irrigation is likely the most important limiting factor for forage production worldwide. Forages require significant water resources for their maximum economic yield, although water-use efficiencies are generally high.

 

- **Environmental limitations.** Depending upon the species considered (alfalfa, grass), low ph., drainage, excessive or untimely rainfall during harvest, excessive cold (short growing season, lack of persistence) or heat, salinity, shallow infertile-soil, or excessive disease or other pests can impose severe limits on the production of alfalfa and other forages.
- **Competing Crops, including those Favored by Governments.** Many of the best agricultural ground has been (or will be) allocated to higher-revenue per hectare grain, oilseed, vegetable, and specialty crops which provide income opportunities and are often favored by government policy.
- **Infrastructure.** The development of domestically traded forages requires infrastructure for rapid baling, handling, and processing. Service industries such as seed, chemicals, and harvesting equipment are also needed and can be a limiting factor currently in many Asian regions.
- **Technology/Expertise/Support.** The production of high-quality alfalfa or grass hay requires expertise in production and marketing that is often lacking currently. Technology tends to be highly transferable but takes time and support.

The lack of quality forage crops grown domestically in Asian countries has created recent opportunities for forage producers in the Western US states, including California.

*Exports of Forage Products from US West Ports*

Prior to 2007, US exports of forage crops to the Asia-Pacific region were minimal. Since the middle of the past decade, hay and forage crop exports from the United States to Asian destinations have increased substantially. California forage producers have specifically benefited from this increase with California hay exports increasing in value from less than $95 million in 2006 to almost $290 million in 2014 (UC AIC). About 99% of US hay exports are shipped from West Coast ports of California, Oregon, and Washington. Average annual volume of forage crop exports in the 2013–2015 period was 24.5% higher compared to the 2007–2009 period despite the California drought discussed below (Table 2). The largest share of this increase comes from the export of alfalfa hay to Asia, which saw a 61% increase in volume during this time period (Table 3).

**Table 2**. Three-year average value of western states' alfalfa hay exports by destination region during periods 2007–2009, 2010–2012 and 2013–2015.

| Global Region | 2007–2009 ($Million) | Share | 2010–2012 ($Million) | Share | 2013–2015 ($Million) | Share |
|---|---|---|---|---|---|---|
| Asia | 2,893 | 89% | 3,308 | 81% | 3,602 | 85% |
| Mid East/N Africa | 284 | 9% | 732 | 18% | 575 | 14% |
| Mexico and Canada | 41 | 1% | 53 | 1% | 31 | 1% |
| Rest of World | 0 | 0% | 1 | 0% | 1 | 0% |
| Total | 3,219 | 100% | 4,095 | 100% | 4,209 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

 

**Table 3**. Three-year average volume of alfalfa hay exports from western ports by destination region during three-year periods 2007–2009, 2010–2012 and 2013–2015.

| Global Region | 2007-2009 (1,000 MT) | Share of Total | 2010-2012 (1,000 MT) | Share of Total | 2013-2015 (1,000 MT) | Share of Total |
|---|---|---|---|---|---|---|
| Asia | 1,010 | 80% | 1,236 | 67% | 1,629 | 78% |
| Mid East/N Africa | 205 | 16% | 553 | 30% | 435 | 21% |
| Mexico and Canada | 36 | 3% | 47 | 3% | 26 | 1% |
| Rest of World | 0 | 0% | 0 | 0% | 0 | 0% |
| Total | 1,251 | 100% | 1,837 | 100% | 2,090 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

*California as Future Supplier of Asia's Forage Crop Needs*

Under normal conditions, the Western United States, and California specifically, are well suited to continue supplying the forage crop needs for Asia's expansion of domestic dairy production. Historically, the California forage industry has not faced the same constraints as Asian forage producers. California's Mediterranean climate, fertile soils and abundant supply of water for irrigation have been ideal for the growth of the state's forage industry. In addition, the geographic proximity of California producers, and producers in western states to major West Coast ports, and the availability of advanced shipping technology, such as double compression of hay bales, further lowers the costs of Asia importing hay from California. A key factor in the increased hay exports has been very favorable export shipping rates to Asia due to a severe imbalance of trade and many empty containers available for western shipping routes.

However, changes in climate has affected western states' competitiveness in supplying forage products to Asia. For example, in recent years California forage growers have faced challenges related to water availability and competition for land from other crops. Since 2000, alfalfa acreage in California has gone from a high of 1.16 million acres in 2002 to 820,000 acres in 2015. For the first part of this period, alfalfa production declines were matched by expansion in corn silage production. But annual average acres of alfalfa in California over the past five seasons are just over 860,000 while silage acreage has also fallen during the recent drought. In 2015 approximately 542,000 irrigated acres of agriculturally productive land was idled, which is 114,000 more acres than 2014 (Howitt et. al. 2015). Farmland used to produce feed, grain and hay crops comprise the largest share of idled irrigated land in 2015. These crops have been cut back in favor of crops such as tree nuts and vegetables which have higher revenue per unit of water. If drought conditions are a result of climate change and continue indefinitely, acreage dedicated to alfalfa and hay production could diminish more, raising the cost of exports. Australia and parts of Europe offer limited competition in the Asian forage products market but this could change if production costs in California increase.

The main source of demand for alfalfa and other forages domestically and internationally is the dairy industry. As noted, California produces about 20% of US milk annually and accounted for about 40% of US exports of dairy products (Sumner 2014). About 80% of the milk produced in California is processed into tradeable manufactured products such as butter, cheese and dry milk powder. Less than 15% of California milk is consumed as beverage products (Sumner 2014).

 

California dairy products such as dry milk powder, cheese and whey are shipped to US, Mexico and Asian markets (UC AIC).

*California Exports of Dairy Products to Asia*

Increased demand for dairy in Asia has led to significant increases in value and volume of US exports of processed dairy products out of West Coast ports (Table 4). Comparing the ten-year average annual values of processed dairy product exports to Asia and the rest of the world for 1996–2005 and 2006–2015, exports to Asia increased by $1.2 billion per year or more than four times the value, while total exports increased more than five times in value. Asia accounts for over 70% of total California dairy product exports during both periods (UC AIC).

**Table 4**. Ten-year average annual value of all processed dairy product exports from west ports globally and to Asia during periods1996–2005 and 2006–2015.

| Global Region | 1996–2005 ($Million) | Share of Exports | 2006-2015 ($Million) | Share of Exports |
|---|---|---|---|---|
| Asia | 276 | 81% | 1,503 | 72% |
| Rest of World | 63 | 19% | 597 | 28% |
| Total | 339 | 100% | 2,099 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

Along with value, the average annual volume of dairy product exports from West Coast ports globally and to Asia also increased substantially. Exports globally tripled in average volume over the past decade compared to the previous period while export volumes to Asia doubled (Table 5). Nationally, dairy exports as a share of annual production grew also. Between 2006 and 2013 exports of dairy products accounted for 1.6% of total US milk production. This share increased to 4% of annual production between 2006–2013 (USDA–ERS 2016). Accounting for almost 40% of total US dairy product exports, California's dairy industry saw substantial increases in value of dairy exports from under $800 million in 2006 to over $2 billion in 2013 and 2014 (UC AIC).

**Table 5**. Ten-year average annual volume of all processed dairy product exports from west ports globally and to Asia during periods1996–2005 and 2006–2015.

| Global Region | 1996–2005 1,000 MT | Share of Exports | 2006–2015 1,000 MT | Share of Exports |
|---|---|---|---|---|
| Asia | 249 | 81% | 688 | 76% |
| Rest of World | 41 | 0% | 213 | 24% |
| Total | 290 | 100% | 902 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

The export of processed dairy products from West Coast ports increased throughout Asia with the majority of gains coming from increased purchases by China, which accounts for an average of 27% of annual volume of dairy product exports to Asia between 2006 and 2015 (Table 6). Average annual volume of dairy product exports from West Coast ports to China during the ten years 2006 to 2015 tripled compared to the previous decade from 44,000 metric tons to 184,000 metric tons (Table 6). In aggregate, annual volume of exports to Asian countries increased over four times to 688 thousand metric tons.

 

**Table 6.** Ten-year average annual volume of dairy product exports from west coast ports to major Asia destinations by country during 1996–2005 and 2006–2015.

| Asian Country | 1996–2005 1,000 MT | Share of Exports | 2006–2015 1,000 MT | Share of Exports |
|---|---|---|---|---|
| China/Hong Kong | 44 | 18% | 184 | 27% |
| Philippines | 26 | 11% | 81 | 12% |
| Japan | 80 | 32% | 105 | 15% |
| Vietnam | 12 | 5% | 57 | 8% |
| Korea | 25 | 10% | 63 | 9% |
| Indonesia | 14 | 6% | 69 | 10% |
| Malaysia | 8 | 3% | 43 | 6% |
| Rest of Asia | 40 | 16% | 86 | 13% |
| Total | 249 | 100% | 688 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

The gains witnessed in dairy product exports to Asia from West Coast ports are primarily led by increases in the volume of export of cheese, butter and dry milk products (Table 7). Dry milk powders, whey products and lactose are the top exported dairy products accounting an average of almost 87% of total annual dairy export volumes to Asia over the past decade. Each of these main exported products increased significantly in export volume from the previous decade to the most recent (Table 7).

**Table 7**. Ten-year average volume of processed dairy product exports to Asia from west coast ports by product during periods 1996–2005 and 2006–2015.

| Dairy Product | 1996–2005 1,000 MT | Share of Total | 2006–2015 1,000 MT | Share of Total |
|---|---|---|---|---|
| Dry milk powder | 46 | 19% | 201 | 29% |
| Whey products | 93 | 37% | 230 | 33% |
| Hard cheese | 14 | 6% | 72 | 10% |
| Lactose and casein | 81 | 33% | 170 | 25% |
| Butter and fat | 0 | 0% | 6 | 1% |
| Other dairy products | 14 | 6% | 9 | 1% |
| Total | 249 | 100% | 688 | 100% |

**Source**: U.S. International Trade Commission, DATAWEB

*Summary of an Econometric Approach*

To supplement the descriptive examination of trends discussed above, we next turn to a brief discussion of econometric estimates of western exports of two key dairy products to the six major Asian importers.

Our focus here has been on longer run Asian demand consideration so we examine twenty years (1996 –2015) of annual export quantities for non-fat dry milk and whey to China, Japan, Korea,

 

the Philippines, Taiwan and Vietnam. As explanatory variables we include exchange rate indexes, population, per capita income, a variable reflecting the implementation of the Korean Free Trade agreement and a dummy reflecting a shock to exports in 2012. The model also includes a lagged dependent variable to account for gradual adjustment and a fixed effect for each country to reflect permanent differences in market size and other characteristics.

Perhaps not surprisingly, these econometric models did not produce results suitable for forecasting. The many fluctuations and ad hoc shifts, with only twenty years of data and focusing on only six Asian countries, did not allow estimation of statistically significant parameters. For several countries imports were almost zero for many years and fluctuated substantially from year to year more recently. Population was gradually expanding and could not account for variation in year to year imports. Gradual income growth too did not capture flux that was likely due to ad hoc shifts in policies as well as local supply conditions.

This more formal approach was informative in suggesting further work in which we estimate underlying parameters of income and population import elasticities from much larger data sets with more countries in which we also control for some local supply-side shifts and perhaps supply shift from export competitors. These estimated parameters could then be included in more formal forecast models.

## Conclusions

Expanding populations and increased wealth in the developing countries of Asia are likely to increase demand for dairy products. To meet this demand Asia will likely increase dairy product supplies from three sources: (1) increased domestic milk production, (2) imports from Oceana and Europe and (3) imports of dairy products from the western United States.

Increasing domestic production of milk within Asia means expanding dairy herd size and improved productivity per cow. Both entail an increased demand for more high quality forages such as alfalfa hay. Asian countries are constrained by climate, land, infrastructure, government policy and technical expertise to produce enough domestic forage crops to support additional dairy production. The natural source for some of the needed forage is the western United States particularly the Pacific Northwestern states and California. Exports of western hay have expanded in recent years even as western milk production has grown and a drought has gripped California. However, drought, climate change and competition from other crops could reduce California's competitiveness in the Asian forage crops market.

Asian milk production alone will not meet the growing demand for dairy products in Asia. Exporting dairy products to Asia has expanded rapidly over the last decade and despite a decline in 2015 (driven by the collapse in dairy product prices) the average value of almost $1 billion per year for the past three years remains well above earlier periods. To remain competitive, however, Californian and other western US dairy and forage industries must improve productivity on farms and in processing at least to keep pace with productivity growth among competitors such as New Zealand and Australia, which face their own challenges.

 

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