Chapter 1. Global Status and Development Trends of Alfalfa

Hu Yuegao and Dennis Cash

Alfalfa has a rich history in China of over 2000 years. In order to understand the complexity and magnitude of the modern alfalfa industry, it is useful to review the history and development stages of the crop throughout the world. The demand for high-quality alfalfa products is rising dramatically in China, and modern domestic production systems are needed.

Section 1: Brief History of Alfalfa

Alfalfa (scientific name Medicago sativa L.), also called lucerne, is the “king of forages”. Its wild relatives (Medicago spp.) are distributed in vast regions, from Spain to China and from Sweden to North Africa. Alfalfa has a cultivation history of more than 4000 years. It was first cultivated in Iran, Turkmenistan and Caucasus in 2000 BC as verified by archaeological evidence, and in Babylon in 700 BC as recorded in written documents. It was described by Greek writers, in 490 BC, introduced to China in 126 BC, and clearly recorded in Greek and Roman writings in 500 AD. Subsequently, alfalfa was spread from Iran to Spain and the Near East in 1100 AD, from Spain to France in 1550, and then to Belgium and Holland by 1565. Alfalfa arrived to the UK in 1650, and came to Germany and Austria in 1750, reached Sweden in 1770, and finally arrived in Russia in the 19th century.

During the early colonization period of the Americas in the 16th century, Spaniards and Portuguese introduced alfalfa to Mexico and Peru, respectively. Alfalfa quickly spread in South America, and several major introductions into the southern US occurred from this region. Thomas Jefferson introduced South American alfalfa to the US state of Georgia in 1736. By 1850 “Chilean” alfalfa was grown in California, and missionaries had brought numerous introductions of alfalfa from Mexico or Peru (“Peruvian”) into Texas, Arizona and New Mexico. There is little historical record about the cultivation of alfalfa in New Zealand, and it is commonly considered that Europeans introduced alfalfa there by 1800. Alfalfa was successfully introduced to Australia in 1806 during its early period of colonization.

In about 1850, alfalfa was introduced from France (“Flamande” or “Flemish” types) to South Africa, and it was then widely planted in arid and semi-arid lands with irrigation. From 1858 to 1910, several cold-resistant landraces of alfalfa were introduced into the northern US and Canada from Russia, northern Europe and high elevation areas of central Asia (“Ladakh”). The first cold-resistant alfalfa variety (‘Grimm’) was successfully cultivated in 1875, and as a result the modern alfalfa industry began to develop in the temperate zone. Presently, most winterhardy or cold-tolerant alfalfa varieties trace to sources of Grimm (or Ladakh) introgressed with Flemish alfalfa. Similarly, the non-hardy or “semi-dormant” varieties trace to sources of African, Chilean, or Peruvian alfalfa.

Section 2: Development of the Modern Global Alfalfa Industry

2.1 Distribution

Alfalfa production has steadily developed because of the crop’s strong vitality, wide range of adaptation, high production, superior quality and multiple uses. Currently, alfalfa production is mainly distributed in temperate regions such as the US, Canada, Italy, France, China and south Russia in the Northern Hemisphere, and Argentina, Chile, South Africa, Australia and New Zealand in the Southern Hemisphere. Alfalfa is grown on about 30 million hectares (ha) worldwide, down from about 33 million ha in the 1970s, and 32 million ha in the 1980s.
The area of production declined by about 10% due to numerous reasons such as high petroleum prices that virtually eliminated the alfalfa dehydration ("dehy") industry in North America, some disease and insect pests, and higher values (or policy incentives) of grain crops. The global area of alfalfa production has rebounded since the 1990s, and has been fairly stable at 30 million ha to the present.

The major alfalfa producing regions are North America with 11.9 million ha (41%), Europe with 7.12 million ha (25%), South America with 7 million ha (23%), Asia 2.23 million ha (8%), Africa (2%) and Oceania (1%). The leading countries in terms of area of alfalfa production (in million ha) are the US (9), Argentina (6.9), Canada (2), Russia (1.8), Italy (1.3) and China (1.3).

Alfalfa is grown intensively or extensively in a wide array of production systems. In North America and Argentina where the alfalfa industry is highly modernized and large-scale, a significant level of public and private research funding has been invested in alfalfa since the 1950s. As a result, improved cultivars, alfalfa technology and seed production have matured and have been transferred around the world.

Alfalfa utilization varies considerably - North America produces mostly dry hay for domestic use, whereas beef cattle direct-graze a significant area of the alfalfa produced in Argentina. In the US, alfalfa is recognized as “Queen of the Forages”, and its planted land area follows only that of corn (maize, Zea mays L.), wheat (Triticum aestivum L.) and soybean (Glycine max L). Alfalfa in the US is grown principally in the northern states or in the west under irrigation. The annual production value of dry alfalfa hay in the US is about $USD 8.1 billion.

In European countries such as Italy, Romania, France, Bulgaria, Spain and Hungary the area of alfalfa production within each country is relatively small. However, alfalfa is intensively grown, and taken as an aggregate the hay and processed alfalfa are major agricultural products in Europe. In contrast to North America, Argentina and Europe the alfalfa production systems in China and Siberia are generally extensive due to the long-standing production practices and natural conditions.

2.2 Alfalfa Marketing
Modern commercial markets for alfalfa have developed parallel to the rapid development of animal husbandry industries during the 20th century, primarily the large-scale dairy industry. Several significant shifts occurred during this period that increased marketing demands for alfalfa. These included the increased consumption of meat, poultry and dairy products, large-scale industrialized animal production systems, and the emphasis by many countries for domestic production of reliable and safe supplies of meat, milk and dairy products.

Following World War II, Japan’s economy recovered rapidly, and its livestock production grew substantially forming a large basic demand for forage imports. In the 1970s, the “Four Asian Tigers” (Hong Kong, Singapore, South Korea and Taiwan) began their rapid economic development and formed a huge demand aggregate for imported forages. By 1990, the Asian-Pacific forage import market reached a scale of 3 million metric tons (MT). This demand came from Japan (80%), Korea (10%) and Taiwan of China (10%).

Mainland China has become a new major market for alfalfa imports due to its rapid expansion in dairy cattle. Currently, the total of all alfalfa exports is about USD $379 million annually (Table 1.1). Despite the Asian financial crisis that began in 2007, the forage demand has remained stable due to the requirement of high-quality alfalfa hay for dairy cattle.
Table 1.1. Alfalfa exports by select regions for the five decades since 1960*.

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<tbody>
<tr>
<td>Hay (Metric tons x 1000)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>North America</td>
<td>167.7</td>
<td>302.7</td>
<td>497.3</td>
<td>61.3</td>
<td>2.6</td>
</tr>
<tr>
<td>Australia</td>
<td>2.2</td>
<td>12.4</td>
<td>74.0</td>
<td>233.2</td>
<td>1205.3</td>
</tr>
<tr>
<td>World</td>
<td>170.3</td>
<td>333.6</td>
<td>574.1</td>
<td>303.2</td>
<td>1213.4</td>
</tr>
<tr>
<td>Pellets and meal (Metric tons x 1000)</td>
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<td></td>
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<td></td>
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<tr>
<td>North America</td>
<td>255.4</td>
<td>285.6</td>
<td>393.8</td>
<td>590.7</td>
<td>383.2</td>
</tr>
<tr>
<td>Australia</td>
<td>-</td>
<td>-</td>
<td>28.8</td>
<td>111.2</td>
<td>76.7</td>
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<tr>
<td>Europe</td>
<td>270.9</td>
<td>351.4</td>
<td>431.9</td>
<td>632.3</td>
<td>603.0</td>
</tr>
<tr>
<td>World</td>
<td>465.7</td>
<td>637.1</td>
<td>858.5</td>
<td>1391.8</td>
<td>1140.8</td>
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<tr>
<td>Value of total alfalfa exports (US$ x 1000)</td>
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<td></td>
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<tr>
<td>World</td>
<td>23,624</td>
<td>96,185</td>
<td>188,371</td>
<td>215,613</td>
<td>378,774</td>
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Table 1.2. US alfalfa exports of alfalfa hay to China since 2004*.

<table>
<thead>
<tr>
<th>Year</th>
<th>Metric tons (MT)</th>
<th>Value (US$ x 1000)</th>
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<tbody>
<tr>
<td>2004</td>
<td>127</td>
<td>12</td>
</tr>
<tr>
<td>2005</td>
<td>251</td>
<td>41.3</td>
</tr>
<tr>
<td>2006</td>
<td>420</td>
<td>81.7</td>
</tr>
<tr>
<td>2007</td>
<td>2321</td>
<td>451</td>
</tr>
<tr>
<td>2008</td>
<td>19,348</td>
<td>4394</td>
</tr>
<tr>
<td>2009**</td>
<td>74,986</td>
<td>18,357</td>
</tr>
</tbody>
</table>


Since 2007, the demand and prices for alfalfa hay have increased dramatically (Table 1.2). Although complete datasets are not available, the trend for dairy-quality hay is rising.

**2.3 Structure of Alfalfa Products**

The alfalfa products of the international market consist mainly of baled hay and processed cubes or pellets. (Alfalfa processing is described in Chapter 4). For efficiency, most hay is compressed into high-density bales (i.e. “double compressed”) for transportation. Currently, about half of all alfalfa exports are comprised of hay, and half of processed alfalfa (Table 1.1). In modern medium- and large-scale dairy operations, chopped alfalfa hay is a significant portion of the daily diet in total mixed rations (TMR). High-lactating dairy cattle are fed 6 to 8 kg of chopped alfalfa hay per day in the TMR, because of its demonstrated superiority to other roughages. For this reason, the demand for baled hay has increased relative to that of cubes or pellets in countries with significant alfalfa imports for dairy cattle. For example, the total alfalfa imports into Japan (in 1991 and 1995, respectively) were: baled (51 and 70%), cubes (35 and 21%) and pellets (14 and 9%). Despite the shift in alfalfa product demand by dairies toward baled hay, the level of processed alfalfa in the export market remains high (Table 1.1).

For many years, the US and Canada had the largest proportion of the world forage export market. For example the proportions of Japan’s forage imports in 2000 from the US and Canada were 76% and 13%, respectively. In recent years, Australia has become a significant exporter of alfalfa hay, and European countries trade high
quantities of processed alfalfa (Table 1.1).

2.4 Current Trends in Global Alfalfa Production
Since the beginning of the 21st century, the total global alfalfa production has slightly declined due to the effects of fluctuating economics for grain crops and animal husbandry, rise of natural gas and petroleum costs, and the expansion of corn or soybean planting encouraged by the “bioenergy” (biological energy) policies of some developed countries.

Several factors appear to be responsible for the reduction in alfalfa production in the US. Dairies and milk production have migrated from the upper midwestern US to California, Idaho, New Mexico and other western states. Herd size and large-scale mechanization of animal handling and feeding systems have accompanied this migration. A second significant change has been the increase in corn silage in rations for dairy and beef cattle in feedlots. In irrigated production systems, corn silage is very competitive in crop value compared to alfalfa. Partially due to these factors, alfalfa production (both tonnage and hectares) has declined in the US by 21% since 1985 (Fig. 1.1).

In North America, a historically large alfalfa export region, the levels of exported alfalfa have remained fairly static since 2000. Exports comprised 1 to 1.7% and 2 to 4% of the total production in the US and Canada, respectively. As noted earlier, there has been some shift in the demand for baled hay vs. pellets or processed alfalfa. For example in Canada, the proportion of total exports (in 1996, 2005) shifted from cubes (55, 24%) to baled hay (21, 60%). This was also related to significant increases in natural gas prices during this period.

Alfalfa production in Europe has also declined slightly since 2000. In France, the area of harvested forages has remained stable at 4.5 million ha and that of natural pasture 3 million ha. Production peaked in 2000 at 6.1 million MT,
and has declined to about 5.6 million MT. The situation in Spain is similar to that of France; its alfalfa production peaked in 2002 at 3.7 million MT, and has declined to about 3.1 million MT.

Global alfalfa hay prices were very strong in 2007 and 2008, with FOB prices in Canada and the US at record levels of $300 USD per MT. These price levels have declined since 2009, but remained at over $200 USD per MT in early 2010. The rapid dairy herd expansion in China has created a large import demand for alfalfa hay, and domestic production cannot presently meet the required supply of hay.

It is anticipated that in response to the increase of alfalfa prices in the international market, the production scale in Europe and North America may slightly increase and stabilize, with emphasis on improved unit-level production. The alfalfa production area in the developing countries of Asia will increase significantly due to the development of the dairy and meat industries. Further, it appears that world forage production and forage markets will diversify. For example, there has been a continued rise in demand in Japan’s imports of gramineous forages such as timothy (*Phleum pratense* L.), ryegrass (*Lolium* spp.), sudangrass (*Sorghum sudanense*), oat (*Avena sativa* L.) and bermudagrass (*Cynadon dactylon*). Of the total forages imported into Japan, alfalfa, grass hay and straw account for 39, 56 and 5%, respectively.

The commercial alfalfa market will continue to grow in Japan, Korea and other areas in southeast Asia where economic development is strong, but agricultural resources are limited. The consumption of meat and dairy products continues to increase, but the finite arable land used for producing human food cannot largely be diverted to livestock feeds. In China, the rapid growth in medium- and large-scale dairies is driving the demand for high-quality alfalfa hay. However, China is uniquely poised for future development of its alfalfa industry. While it is currently a large import consumer of alfalfa, China has the potential for vast and sustainable alfalfa production systems. Further, China’s proximity to countries with high import demands such as Japan and Korea will be a factor in the future development of the alfalfa industry in China.

In the future, alfalfa will be utilized for purposes beyond livestock feed. Experimental research has been conducted on extraction of natural colorants, human nutrients, natural herbicides and renewable energy sources from alfalfa. Some of the research has been industrialized and is expected to create new demands for the international marketing of alfalfa.

**Section 3: Alfalfa Development in China**

### 3.1 History of Alfalfa Production

Alfalfa has been grown in China for over 2000 years. It was recorded in the book “The Western Territories of Han” that alfalfa was introduced to China in the early Han Dynasty (206 BC to AD 220). In 126 BC, Emperor Wu of Western Han dispatched Zhang Qian to the western countries, who purchased famous blood-sweating horses and alfalfa seeds from Dawan. Alfalfa was first cultivated in palaces as ornamental plants and forage for war horses, and later transferred to the area of Shaanxi. Some important historical records of alfalfa included:

A. Qi Min Yao Shu of the Northern Wei Dynasty (386-589) described the planting method and feeding value of alfalfa.

B. Li Shangyin, a poet of the Tang Dynasty (618-907), wrote in his poem *Mao Ling* “alfalfa flowers cover the near suburbs”.

C. The systematic books *Qun Fang Pu* of the Ming Dynasty and *Nong Can Jing* of the Qing Dynasty (1644-1911) made comprehensive references to alfalfa’s cultivation techniques, harvest methods, and feed and medicinal values.
D. The publication *Jiu Huang Jian Yi Shu* of the Qing Dynasty recorded quotes of an old farmer in Zhili who said:

i. “*alfalfa must be sown in July together with buckwheat so that autumn can prevent alfalfa from scorning sun. If sown in May, alfalfa must be mixed with millet.*” (This coincides with today’s practice of companion plantings of alfalfa with buckwheat (*Fagopyrum esculentum*) or millet, *Setaria* sp.)

ii. “*More alfalfa will get more fertilizer for field fertilization*”.

iii. “*It is not favourable to feed swine simply by bran. Swine can eat land or water non-toxic grasses and roots. Alfalfa is the best as it can re-grow after cutting, and can be harvested for several times a year, very beneficial.*”

Alfalfa was widely planted, and people had a thorough understanding of alfalfa cultivation and utilization in the Ming Dynasty (1368-1644). During this period, alfalfa and known production techniques spread to the central plains and the northwest regions of China. Shaanxi, Gansu, Shanxi and Xinjiang became the four old alfalfa production areas. Alfalfa was first cultivated in southern Ningxia during this period.

The Chinese people have had profound knowledge of alfalfa, and this crop has spread in an expanding area to Xinjiang in the west, Heilongjiang in the north, the middle and lower reaches of the Yangtze River in Jiangsu in the south, and even to the Tibetan Plateau. In 1949, about 330,000 ha of alfalfa were grown in China, accounting for 1% of the national total arable land area. Before 1946, the alfalfa planting area in Shaanxi and Gansu accounted for 5 to 8% of the total arable land area in these provinces. Since the 1980s, alfalfa has increased and remained stable at about 1.3 million ha. The alfalfa is mainly distributed in 14 provinces and regions in the Yellow River valley and to its north.

During the two millennia of alfalfa production in diverse areas in China, many genetic resources of alfalfa were evaluated, selected, propagated and transported. To date, 80 local alfalfa varieties (“landraces”) have been collected and characterized. Between 1986 and 2000, 36 alfalfa varieties were examined and registered by the National Forage Variety Certification Committee, including 17 local, 17 improved, one introduced variety, plus one variety from a “wild” alfalfa species. Concurrent with the long process of alfalfa planting and seed propagation in China, some prominent livestock breeds arose in the major alfalfa production areas. These included the Qinchuan cattle from central Shaanxi, the Guanzhong donkey from southern Shanxi, Jinan cattle in eastern Gansu, and the Tan sheep in central Ningxia.

In recent years, China has rapidly progressed in technical research of alfalfa genetics, variety development, cultivation, processing, storage and utilization. Alfalfa was traditionally grown and fed on the farm (as “one mu per cow”), however alfalfa is becoming an important cash crop for hay, meal, cubes or pellets. The alfalfa market in China has a large potential to meet the increasing demands for high-quality alfalfa for dairy cattle and other livestock. These industries are motivating large-scale and highly efficient alfalfa production to meet the domestic demands. In short, the technical gap between China and the West is narrowing.

3.2 Basic Zones of Alfalfa Production in China

Numerous classification schemes are used to describe alfalfa’s areas of adaptation, reaction to stress such as pH or salinity, pest resistance, and yield potential. Two major environmental
factors for alfalfa production are temperature and precipitation (or the availability of irrigation). Types of alfalfa are fairly-well delineated depending on the length (or absence) of a frost-free period. Alfalfa in lower latitudes grows year-round and has no requirement for cold tolerance or a period of winter dormancy. In contrast, alfalfa grown at higher latitudes faces short growing seasons (such as under 120 frost-free days), and it must be dormant during the winter and possess some level of “winterhardiness”. Varieties of alfalfa at these two extremes are called “non-dormant” and “dormant”, respectively based on their growth habits during winter. A middle category is called “semi-dormant” alfalfa. The level of alfalfa winterhardiness is affected by many factors such as altitude, duration of frost period, soil properties, absolute cold temperatures, and snow cover.

**Fall Dormancy:** A numeric classification system to estimate the potential winterhardiness of alfalfa varieties based on their level of autumn or fall dormancy (FD) has been used in the US for over 30 years. The FD evaluation is based on the level of autumn growth (at first frost) of alfalfa following harvest in late summer. The standard test consists of the crop height of individually-spaced plants \(N > 100\) in replicated trials compared to verified check (or control) varieties. The current check varieties range from ‘Maverick’ (FD = 1, earliest dormancy) to ‘UC-1465’ (FD = 11, most non-dormant). In general, varieties with FD similar to Maverick are adapted to extremely cold areas, where forage is harvested once or twice per season. In contrast, the extremely non-dormant varieties such as UC-1465 are grown in irrigated low-desert areas where nine or more harvests occur per year. A newer standardized test for winterhardiness (WH) test has been developed, and new varieties are described by both FD and WH (Source: [http://www.alfalfa.org/](http://www.alfalfa.org/)).

In accordance with the “Zoning of Perennial Forage Seeds of China” and recent experimentation, the alfalfa adaptation areas in China were divided into seven major regions: northeast zone, Loess Plateau, Inner Mongolia Plateau, Yellow and Huai River zone, Gansu-Xinjiang zone, Qinghai-Tibet zone, and South Yangtze River zone.

A. **The Northeast Zone** has a complex climate, with a cold temperate area, medium temperate area and a warm temperate area from northeast to southwest. It mainly has a continental monsoon climate with a short, warm, and wet summer and a long, frigid winter. Its annual average temperature is \(-6^\circ\) \(C\) to \(10^\circ\) \(C\), and annual precipitation is 400 to 1000 mm. It has vast areas of flat land, fertile soil, sufficient light energy and significant water resources, which are superior conditions for a developing alfalfa industry. Varieties with strong winterhardiness (FD 1 or 2) should be selected. This region has several river ports and it is near seaports. Therefore, high-quality forages should be considered for transport within China or to nearby export markets.

B. **The Loess Plateau** has a continental monsoon climate characterized by cold winters, warm summers and a dry climate. The annual average temperature is \(-4^\circ\) \(C\) to \(13^\circ\) \(C\) and the annual precipitation is 400 to 700 mm. It is one of the most ancient alfalfa production areas in China. However, the region is mostly hilly and mountainous with few plains for large-scale crop production. Alfalfa and other crops are widely grown on terraces, which generally consist of deep silt soils. Alfalfa varieties of FD classes 2 to 4 with some level of known drought tolerance are best suited to the Loess Plateau.

C. **The Inner Mongolia Plateau** is one of China’s major grassland areas. It is a pastoral-farming region and consists mainly of hilly land and plateaus. It is arid or
semi-arid, windy, and with a short growing season. Its annual average temperature is -2°C to 6°C, and annual precipitation is 250 to 400 mm. Alfalfa production in this area is primarily for winter forage for cattle and sheep. Across most of this region, varieties with drought tolerance and winterhardiness (FD classes 1 or 2) should be grown. Currently there is expansion in large dairy cattle operations and areas of developed irrigated farmland for hay (FD classes 2 or 3) or alfalfa seed production.

D. The **Yellow River and Huai River region** faces the Pacific Ocean to the east and consists of mainly plains and terraces. This region is strongly impacted by monsoonal conditions, with warm, wet summers and cold, dry winters. Its annual average temperature is 4°C to 17°C, and the annual rainfall is 600 mm. The region has fertile soils, and a relatively high degree of crop diversification and mechanization. Some soils have a moderately high salt concentration, but the region is very suitable for alfalfa production. Prior to establishing alfalfa, the soil should be desalinized by flood irrigation and drainage. Alfalfa varieties should be salt-tolerant, and moderately winterhardy or semi-dormant (FD classes 3 to 6). This region is proximate to many dairies and large hay markets. It has become an important base for alfalfa seed production for these reasons, this area has become the major domestic alfalfa seed production base for China. In the future, this region is anticipated to significantly increase in alfalfa forage and seed output.

F. The **Qinghai-Tibet Plateau** has an upland climate characterized by extreme variations in daily and seasonal temperatures. This region is mainly utilized for pasture, with small pockets of grain production. Alfalfa production is limited to areas such as the south Tibet river valley, east Tibet Chuanxi river valley, and the Qaidam Basin. Alfalfa production is mainly for on-site or local utilization. Alfalfa varieties should be cold tolerant (FD class 1) and grazing tolerant for optimum production in this zone.

G. The **South Yangtze River zone** includes both tropical and sub-tropical climate types in southern China. This region has high rainfall (800 to 1800 mm annually), temperatures, and humidity. Summer alfalfa growth declines during summer heat, and haymaking is difficult due to the high humidity. Alfalfa breeders and agronomists have recently adapted a system of forage production which capitalizes on the vigorous alfalfa growth in winter and spring.
The alfalfa is harvested two to four times per year in the winter and spring, and is mostly dormant in the summer and autumn. The varieties adapted to this system are semi-dormant (FD classes 5 to 7) and should have good foliar disease resistance.

3.3 Recent Developments in China’s Alfalfa Industry

A. “The direct cost is huge and the lesson is profound” Massive adjustments have occurred in China’s alfalfa industry since the mid-1990s. Since 1994 several new state policies supported alfalfa development throughout China. The establishment of large-scale alfalfa plantations and dairies began in Cangzhou, Hebei Province and Dongying, Shandong Province in 1994, and these experienced steady and profitable progress. Expansion occurred in the southern provinces after 1997 based on successful demonstrations by the Shanghai Milk Association and projects in Zhenjiang (Jiangsu) and Nanping (Fujian). During the same period, the state policy of returning farmland to grassland or forests supported vast erosion control projects around Beijing-Tianjin starting in 1998. Ecological construction projects using alfalfa and other perennial forages were initiated in Hebei, Shanxi and the western provinces. Grazing restrictions were initiated in the western provinces to restore grassland health, and as a result alfalfa was widely planted for a feed source for confined livestock.

Alfalfa planting spread rapidly throughout China during this period. At its peak in 2001, China imported more than 10,000 MT of alfalfa seed; 2000 MT from a sole seed company in Saskatchewan, Canada. As an example of rapid alfalfa development, Beijing had very little alfalfa production in the Beijing vicinity in 2000. After alfalfa establishment, several processing facilities and large dairies were constructed, and by 2004, the alfalfa area reached 20,000 ha. Domestic organizations for the forage industry held several relevant seminars, promoting the national alfalfa industry during this high tide of development.

By the end of 2005, the total alfalfa area approached 2 million ha in China. Gansu had the largest area of alfalfa planting at 0.6 million ha, followed by Ningxia with about 0.4 million ha. There were also large-scale alfalfa plantings in Shanxi, Shaanxi, Inner Mongolia, Xinjiang and Tibet. During this period, there were more than 300 forage enterprises of various types in China, including the companies Hengdian Grass (in Shandong), Guofu (in Hebei), Daye (in Sichuan and Gansu), Jinmu and Haobang (in Beijing) and Huolanshan (in Ningxia).

In 2004, the government implemented the new food security policy, including the “three subsidies and one exemption”. Most of the regions with emerging alfalfa development experienced rapid declines. Many young alfalfa fields at a stage of high productivity were ploughed out for grain production. The alfalfa industry in the eastern provinces in the Yellow and Huai River valley areas was almost eliminated. Alfalfa production in the south declined, and the development in the western provinces stalled. By 2005, the total alfalfa output in China dropped to about 2 million MT, and the vigorous development of the alfalfa industry slowed considerably.

In summary, the ten-year development project for the alfalfa industry in China was not very successful, and many relevant companies changed their line of production or closed down. The forage product market generally went into chaos, and the prices rose dramatically. By 2008, the CIF (delivered) price of high-density alfalfa
bales with over 18% crude protein in Shanghai reached $US 450 per MT. The forage shortages and high values have created a significant new wave of enterprises and interest in the alfalfa industry in China.

B. “The technological gap between China and foreign countries has been greatly narrowed”. During the 10-year alfalfa development period, many new technologies were introduced and adapted for conditions in China. These included both mechanical and biological agents used in alfalfa production systems. Large-scale plantations were demonstrated using large tractors, mowers, conditioners, rakes, balers, irrigation systems, and processing equipment such as pellet and cube mills. Over 100 types of materials including imported alfalfa varieties, rhizobial inoculants, and silage inoculants were imported or developed. A significant level of expertise has been gained through practice about hay conditioning, ensiling technology, feed programs such as TMR for dairy herds, alfalfa variety testing and classification, herbicide technology, and disease and pest management, and these technologies have been maturing.

Forage Science is offered as a major in more than 10 universities, and about 100 institutions are working in alfalfa scientific and technological research. More than ten universities and research institutions are capable of training MS or PhD students in Forage Science, so the knowledge level of research personnel and agronomic management has been significantly improved.

There are seven professional journals on forages, and three scientific forage societies or technical associations. Alfalfa professional websites and web pages have increased in both quantity and quality. Routine communication channels have been established among industry, academic and technological circles within China and with several countries, enabling a convenient and rapid exchange in alfalfa technology and information. These activities have reduced the gap between China’s alfalfa industry and that of more advanced countries.

C. “China’s alfalfa industry is at the early development stage”. Four points indicate that China’s alfalfa industry is still at its early development stage. First, the overall development scale is still small. Up to present, alfalfa has occupied only 1.3 million ha. The annual quantity of high-quality commercial alfalfa hay (for example over 18% crude protein) has only reached about 200,000 MT.

Second, the current alfalfa industry in China is restricted by low or unstable production. Specifically, the large areas of alfalfa remaining in the Loess Plateau (supported by the policy of returning farmland to forests or grassland) and the Beijing-Tianjin (ecological control project) are on small tracts and managed by traditional farming methods. The majority of these alfalfa stands are quite old, dating back to 2000 or 2001. Further, the alfalfa industry in highly-productive areas such as the Hexi Corridor has a relatively high technical level, but grain crops have widely displaced alfalfa. Therefore, the current limited alfalfa production capacity is unable to meet the huge domestic market demand or to participate in international trade. Third, science and technology achievements have not actually entered into the alfalfa industry. In some cases, formal research has not been applied to field conditions, and in other cases successful technologies are not
delivered or adapted due to poor communication channels or lack of training for extension personnel.

Fourth, the development of the alfalfa industry remains in a situation of spontaneous growth and self-perishing. There is no definite state support policy for alfalfa development, and the industry in China is still in a high-risk status. However, many technological advances, talented personnel, expertise, and equipment have been accumulated over the past decade.

Section 4: The Emerging Alfalfa Opportunities in China

Radical changes are occurring in global agriculture. As China strives for self-sufficiency in its food production, the alfalfa industry will play a critical role.

4.1 The domestic market demand is huge and irreversible

China’s population growth, rapid economic development, and state policy reforms have had massive impacts on the recent scale and output of the livestock industries. The per capita consumption of dairy, meat, eggs and other animal products has risen dramatically for the past 20 years, and the expansion will continue. From 1996 to 2005, the output of meat in China increased from 45.8 to 77.4 million MT, poultry and egg production grew from 19.7 to 28.8 million MT, and dairy products increased from 7.4 to 28.6 million MT. The annual growth rates of these products were 8, 6 and 29% higher, respectively, than that of all grain production during the period. Increased production of feed grains and roughage will be required to support the growing livestock demands.

In many developed countries in Europe and the West, the majority of the agricultural land base is dedicated to the production of livestock feed and forage, and China is anticipated to complete this transition in about 2020. Clearly, large shifts in land use patterns in crops for human food vs. animal feed can have major socio-economic effects. A clear example of this dilemma in China is the soybean crop. Soybean was domesticated in China, and is extensively used for many food, feed, oils and industrial purposes.

Since 1995, China has been the world’s largest importer of soybeans. Based on current growth trends in the livestock industry, the soybean meal deficit in China is predicted to be over 26 million MT annually from 2010 through 2030. While soybean is a large traditional Chinese crop, China has lost price leverage in the international market for soybean, soybean meal and soybean oil. This has resulted in unstable and volatile prices for food, feed and animal products. To cope with the increasing demands for food and livestock feeds, China must balance many social, economic and environmental issues.

Enhancement of efficient alfalfa production and the entire forage industry is a feasible strategy to stabilize livestock feed resources in China.

4.2 International agricultural trade is in a great adjustment period

Global agriculture has experienced a high level of volatility since 2000, due to numerous interrelated factors. In the last decade, crude oil prices ranged from about $US 21 (2002) to over $US 140 per barrel (2008). High fuel prices impacted all levels of agricultural production including farm fuel, fertilizer, transportation to primary markets, processing and distribution to domestic or international markets. The prices of vegetables, food, and commodity grains rose significantly in most countries. The subprime mortgage and investments crisis in the US in 2007 evolved into global financial problems. This simultaneous volatility of energy costs, food prices and financial crisis is unprecedented in the history of global trade.
Many commodity-exporting countries have begun to adjust their farm production structures in response to markets or internal policy decisions. For example, rapid and large-scale development of corn ethanol production occurred in the US during the 2000s to reduce dependence on imported fuel. The increase in US corn acreage directly impacted the acreage and values of the other major crops such as soybean and alfalfa. Traditional feed prices also increased, and large supplies of dried distiller grains (by-product from corn ethanol) became a new animal feedstuff.

The US remains the largest alfalfa-producing country, but its area of alfalfa dropped from 9.5 million ha in 2000 to 8.8 million ha 2007 (Figure 1.1), and hay output declined 11% during this period. In Saskatchewan, Canada’s major alfalfa-producing province, the number of large alfalfa processing plants – five in 2000, declined to one seasonal pellet mill in 2008. Alfalfa production also declined in Europe during the last decade. In summary, it is clear that China’s alfalfa production and other forages is very risky. Domestic alfalfa production should be emphasized to meet the growing livestock demands.

Section 5: Constructing a Modern Alfalfa Industry in China

5.1 Perfecting the Technology System of Alfalfa Production

The framework of China’s alfalfa technological system exists but there are still many needs. To sustain the development of the alfalfa industry in the next stage, research should address every technical step from basic alfalfa science and breeding through its utilization by livestock to establish an integrated system. Governmental departments should support long-term and in-depth alfalfa research, and promote new products and new technologies by making use of various educational media. Extension and promotion of alfalfa should be harmonized among the various bureaus which currently deal with forage production, including the Bureaus of Forestry, Agriculture and Animal Husbandry, as well as the Poverty Relief Offices, and Agricultural Technology Promotion Centres.

5.2 Establishing Standards for the Alfalfa Industry and for Forage Quality Control

Through the progress of globalization, China is increasingly impacted by the world market for forage and feed products. The mature and large-scale alfalfa industries in Europe, North America and Australia have recently resulted in significant supplies of imported forages. In many cases the imported alfalfa is less expensive (despite high freight costs) and has higher forage quality than domestic hay.

The growing dairy industry in China will require consistently stable supplies of high-quality alfalfa hay. The hay quality standards required for dairies in Japan, Korea, and Taiwan are now accepted in Chinese dairies. Therefore the domestic alfalfa industry for hay and all processed feeds must rapidly adopt these quality standards. For quality control in the industry, a standardized network of testing laboratories and labelling should be established in coordination with researchers, producers, and the government.

5.3 Optimizing the Structure of the Modern Alfalfa Industry

At the state level, the structure of the alfalfa industry should adhere to the principle of “being suitable to local conditions”. Appropriate alfalfa varieties and production and processing practices should be recommended according to local resource characteristics. In regions south of the Yangtze River and Huai River, the alfalfa production and processing systems are now mature. Therefore, the next stage development of the alfalfa industry in China should occur in
the northern region. This includes areas of Gansu, Hebei, Xinjiang and Shandong, and newly rising regions such as Shanxi, Henan and three northeast provinces.

In the areas with fragile ecology such as Inner Mongolia and Qinghai, emphasis should be made to integrate alfalfa with other forage species for pasture restoration. Expansion of seed production should occur in areas of reliable potential, such as Gansu and Xinjiang. Commercial high-quality hay production should be concentrated first near areas of large dairy herd operations. Commercial hay production in northern and northeastern western China should also strive for high-quality hay to ship to domestic markets near dairies.

5.4 Developing an Active Coordination with Other Forage Sectors
As the king of forages, alfalfa has many advantages, but it also has several disadvantages. One is its tendency to cause bloat of grazing ruminant animals due to its high concentration of soluble proteins. Therefore, alfalfa is restricted to being a harvested crop because it is not feasible to utilize a monoculture of alfalfa as pasture for sheep or cattle. A related problem is that much of the protein in alfalfa forage is rapidly degraded and is lost prior to complete microbial digestion. A third forage quality factor is the increased fibre concentrations that accompany alfalfa’s peak forage yields at flowering. High fibre (and low fibre digestibility) directly leads to a reduction of milk production and other animal performance.

Alfalfa also has some developmental limitations. For example, during seedling growth it is very weak in comparison to weeds and other species. In rainfed environments, it frequently has poor plant growth. These limitations of alfalfa are often overcome by crop mixtures with adapted graminous species such as awnless bromes (Bromus spp.), fescues (Festuca spp.) and others. Mixed stands of alfalfa and grasses can solve grazing limitations, improve final stand composition, improve the plant canopy for holding soil structure and limiting wind erosion, and the alfalfa reduces the fertilizer requirement for nitrogen.

Various improvements in alfalfa’s tolerance to salinity, pH, drought, and numerous diseases and pests will be added over time to increase its adaptation and production. Current genetic transformation research in these areas is very promising in alfalfa. Besides alfalfa, there are numerous diverse graminous forages that are becoming important in specialty markets. Vast improvements are being made in the yield and digestibility of corn silage varieties. For these reasons, basic agronomic research and breeding should also be emphasized in promising forage species other than alfalfa.

5.5 Developing in Coordination with Local Animal Husbandry Industries
At the national level, the alfalfa industry is rapidly adjusting to the international scale and standards of the dairy industry. At the regional and provincial levels, the alfalfa production systems must be scaled for the local conditions and local animal husbandry industry first, and larger distant markets second. Farmers should be educated about forage quality standards in order to optimize their product for the local livestock markets. In this way, the alfalfa industry can reduce market risks, increase value-added opportunities, raise the proportion and competitiveness of local animal husbandry, and reduce processing and transportation costs, thus ensuring a sustainable alfalfa industry.

5.6 Building a Knowledge-Intensive Alfalfa Industry
China has developed a significant platform of contemporary scientific and technological
advances in alfalfa production. The number of university programs and graduates in Forage Science are increasing annually. The construction of a knowledge-intensive alfalfa industry should be emphasized to guarantee its healthy and sustained development. Knowledge in all areas of alfalfa production must be spread to the provinces and county-level personnel by training and all modes of instruction, such as the internet. County-level demonstrations and training should be provided for farmers in order to grow the alfalfa industry in China.

5.7 Establishing an Alfalfa Industry Association
Currently there are several academic or industry forage associations in China. It would be advantageous to create an over-arching alfalfa industry association comprised of research scientists, field agronomists, extension personnel, producers, input suppliers, marketers, processors, and consumers. This association could effectively establish forage quality standards, recommend needed research and infrastructure, advise the government on new policy or trade issues, and gradually improve the alfalfa production system in China.

5.8 Building a Successful Alfalfa Seed Industry
Sustained alfalfa expansion in China will require a viable alfalfa seed industry. Currently, most alfalfa seed is imported, primarily from Canada, the US and Australia. The continued reliance on imported seed poses the risk for price volatility, placement of non-adapted varieties and the potential for introducing new disease or weed pests. For long-term development, most regions in China will need a dedicated alfalfa breeding program, with seedstock and commercial seed multiplication bases in the western provinces. This model would guarantee that old local landraces and new varieties are appropriately tested and exploited for local conditions. Also, the long-term efforts to add genetic resistance to local disease or insect pests can begin at the local level.

Excellent seed production conditions exist in Xinjiang and Gansu, and potentially areas in Inner Mongolia and Ningxia. In addition to the breeding, testing and seed production activities, new facilities for seed processing, treatment, and seed quality control should be established for distribution of high-quality alfalfa seed within China.

References and Further Reading


