International Journal of Applied Agricultural Sciences
2019; 5(1): 1-13
http://www.sciencepublishinggroup.com/j/ijaas
doi: 10.11648/j.ijaas.20190501.11
ISSN: 2469-7877 (Print); ISSN: 2469-7885 (Online)

Review Article

Analysis on the Situation of USA Pima Cotton Production

Liwen Tian[1], Kong Jie[1], Weng Qin[2], Xinmin Ning[1, *], Jianping Cui[1], Haijiang Xu[1], Rensong Guo[1], Tao Lin[1]

[1]Institute of Economic Crops, Xinjiang Academy of Agricultural Sciences, Urumqi, China

[2]Institute of Economic and Technological Information, Xinjiang Academy of Agricultural Sciences, Urumqi, China

Email address:
1365400936@qq.com (Liwen Tian), nxm7833@163.com (Xinmin Ning)

[*]Corresponding author

To cite this article:
Liwen Tian, Kong Jie, Weng Qin, Xinmin Ning, Jianping Cui, Haijiang Xu, Rensong Guo, Tao Lin. Analysis on the Situation of USA Pima Cotton Production. *International Journal of Applied Agricultural Sciences*. Vol. 5, No. 1, 2019, pp. 1-13. doi: 10.11648/j.ijaas.20190501.11

Received: October 22, 2018; **Accepted**: November 30, 2018; **Published**: January 21, 2019

Abstract: Based on the analysis of the natural ecological conditions, yield, quality, brand, equipmen, technology, planting distribution, planting benefits, policy and social service in the Pima cotton-growing region of the United States, the following advantages and successful experiences of Pima cotton production in the United States were clarified: first, USA Pima cotton producing area is mainly concentrated in San Joaquin Valley (SJV) of California, where the water supply is enough, water and soil conservation good, light and heat resources abundant; second, the average planting scale in 2013-2017 was 788 32.8 hm^2/ year, with the total yield of 127 540 t/year，the average yield per unit of 1 613.10 kg/hm^2. The Pima cotton yield of the United States accounted for 25.1-47.0% of total ELS production in the world, ranking first among all ELS planting countries. American Pima cotton is shown in strong fiber strength, good micronaire value, proper uniformity, high color grade and leaf grade. So American Pima cotton is the most influential, it has become a popular raw material for textile enterprises to produce high-grade cotton fabrics. The raw materials for many brands of cotton textiles are designated as Pima cotton. The final net income of the farm owner is an average of \$555/hm^2. third, equipment material and technology is practical, advanced. The high yield and pest-resistant variety, high-efficient new fertilizers with low pollution, new pesticides (including herbicides, pesticides, defoliation ripener, chemical regulator), the integration of water, fertilizer and drugs, remote monitoring and control, as well as all kinds of modern agricultural machinery, advanced processing and testing equipment, all of which are first and widely used in the United States. Fourth, feasible and reliable modernized intensive farm management mode with large-scale agricultural machinery operation; fifth, although high production cost of American Pima cotton, high-efficient social services and policy support system, as well as reasonable planting distribution, good brand influence, synchronization of high yield and good quality with large-scale benefits. In a word, advantages and successful experiences of American Pima cotton production can provide other countries, especially China, Egypt with good reference and models in ELS production, and then the world ELS production level will be comprehensively improved.

Keywords: Pima Cotton, Natural Ecology, Production, Quality and Brand, Equipment and Technology, Distribution and Organization Form, Benefits, Services

1. Introduction

It is widely believed that extra long staple (ELS) cotton is a species of cotton plant that has been cultivated to have extra-long staple fibers - longer than 1 3/8″inch (34.93 mm), and fiber strength and fineness better than those of upland cotton [1-2]. American Pima cotton is a typical ELS cotton, which had a planting area of 97 933 hm^2 in 2017 with the yield of 158 000 t. Ensure that the reliable quality ELS cotton is supplied to the well-known textile enterprises, and the users reflect well. At present, there are many high-end cotton textile Raw material is designated as Pima cotton produced in the United States. So it is necessary to analyse the characteristics of natural ecological conditions, yield, quality, brand, equipment, technology, planting distribution，planting benefit, policy and

social service in the Pima cotton-growing Region of the United States, the advantages and successful experiences of Pima cotton production in the United States were summarized. They can provide other countries, especially China, Egypt, good reference and models in ELS production, and then the world ELS production level will be comprehensively improved [3-5].

2. Analysis

2.1. Natural Ecology

Due to the unique requirements of Pima cotton on natural conditions, and the pursuit of the producers on the yield, quality, benefit, after about 200 years of practice and exploration, especially in recent 30 years, the American Pima cotton planting area has been rapidly transferred from Arizona to another state -- California (both Arizona and California belong to the west cotton producing area in the United States). Actually, before 1991, Arizona was the largest Pima cotton producing state in the United States for a long time, but since 1992, California has become the largest American Pima cotton producing state, and the Pima cotton producing area is mainly concentrated in San Joaquin Valley (SJV) of California. [4-6].

The investigation shows that cotton field in the Pima cotton planting concentration area of San Joaquin Valley has a topsoil thickness of 25.4 cm, and the texture is sandy clay loam. Substratum is light brown and brown, indurated duripan with 70-90% silica-sesquioxide cementation. There are a variety of microorganisms in the soil, and the organic matter and nutrient contents are above the average. Experts generally believe that the soil of the cotton producing area is active, thermal, abruptic durargid, so the soil has good water retention and nutrient preserving capabilities [6-7].

Located at 36°46′54″ N, 119°47′32″ W, Fresno lies in the center of the San Joaquin Valley. It is the largest Pima cotton planting county in the United States, and adjacent to it are the only 2 other Pima cotton planting counties in California. In this paper, the climate related data of Fresco in 1981-2010 (Table 1) are used to reflect the climate characteristics of the American Pima cotton producing area [6, 8]. As shown in Table 1, the annual average high temperature, low temperature and the difference between the two are 24.9°C, 11.1°C and 12.1°C, respectively, and the difference between the average monthly high temperature and average monthly low temperature in May-September reaches 16.5°C. The large temperature difference is conducive to the increase of cotton photosynthate accumulation and yield. December and January are the coldest months, and the average low temperature in the two months is 3.3°C and 3.5°C, respectively with an average of 3.4°C; July and August are the hottest months with the average high temperature of 36.5°C. The difference between the monthly average high temperature and monthly average low temperature of the year is 12.1°C [4, 8]. Annual precipitation is 292.1mm, mainly in winter. Average annual sunshine percentage reaches as high as 79% with the annual sunshine time up to 3 550 h. Summers provide considerable sunshine, with July peaking at 97% of the total possible sunlight hours; conversely, January is the lowest with only 47% of the daylight time in sunlight because of thick tule fog [4, 8].

There are 166.0 days with the daily average over 32°C, and the days with the temperature of below 0°C is 49. Measurable precipitation falls on an average of 49 d annually. Snow is a rarity. The summers are very hot and dry, and last for a long time. There is little rainfall during the growth period of cotton, especially the late stage of cotton growth, when the climate is typically dry with little rain. On the other hand, winters are mild and moist, with long frost free period, thus displaying Mediterranean characteristics, which is helpful for the artificial control of cotton growth and development, reaching the goal of high yield [4, 8].

Further analysis on the extreme meteorological data of Fresno county shows that the official record high temperature is 46.1°C, set on July 8, 1905, while the official record low is -8°C, set on January 6, 1913, and no freeze occurred during the 1983/1984 winter season.

It can be concluded that the San Joaquin Valley has good soil and light-heat resources for Pima cotton planting.

Table 1. *The temperature, precipitation and sunshine of Fresno (local airport) in different months from 1981 to 2010.*

Month	January	February	March	April	May	June	July
Average high temperature //°C	12.8	16.4	19.8	23.7	28.9	33.3	36.9
Average low temperature //°C	3.5	5.3	7.6	9.7	13.4	16.9	19.8
Difference between average high temperature and low temperature	9.3	11.1	12.2	14.0	15.5	16.4	17.1
Average precipitation //mm	55.6	51.6	51.6	24.1	10.9	5.3	0.3
Average raining days (≥ 0.254 mm) //d	7.6	8.6	7.5	4.5	2.2	0.7	0.2
Average sunshine percentage //%	47	65	77	85	90	95	97

Table 1. *Continued.*

Month	August	September	October	November	December	All year round
Average high temperature //°C	36.2	32.7	26.4	18.4	12.7	24.9
Average low temperature //°C	19.0	16.4	11.7	6.3	3.3	11.1
Difference between average high temperature and low temperature	17.2	16.3	14.7	12.1	9.4	12.1
Average precipitation //mm	0.3	4.3	16	27.2	45	292.1
Average raining days (≥ 0.254 mm) //d	0.3	1.0	2.5	5.5	7.5	48.1
Average sunshine percentage //%	96	94	88	66	46	79

Note: The data source from the National Oceanic and Atmospheric Administration (NOAA) and the Weather Channel of the United States.

2.2. Production, Quality and Brand

2.2.1. Production and Quality

The three largest ELS producing countries in the world are China, the United States and India, in which the total production of Pima cotton in the United States presents overall upward trend, especially in the past 30 year. On the other hand, there still exist obvious stage differences in the development, which in specific is as follows: "slow rise (before 1983) - high rise (1983-1989) - rapid decline (1989-1995) - fast rise (1995-2004) - high fluctuation (since 2004) (Figure 1). In 1983-1989, the total Pima yield increased to the highest of 150 600 t (1989) quickly from 20 680 t in 1983; in 1989-1995, the highest yield reduced quickly to the lowest yield of 73 590 t in 1995; in 1995-2994, the yield increased from the lowest of 80 120 t (1995) to the highest of 162 420 t (2004); since 2004, the highest yield was in 2007, reaching 185 500 t, while the lowest in 2009 of 87 100 t. During the same period, the cotton planting trends all over the United States are basically the same, and the average planting scale in 2013-2017 was 788 32.8 hm^2/year, with the total yield of 127 540 t/year, which is as shown in Table 2.

The Pima cotton yield of the United States accounted for 25.1-47.0% of total ELS production in the world, with an average of 37.6% (2012-2017), ranking first among all ELS planting countries. The ELS exports in the United States accounted for 57.7-75.4% of the total in the world, with an average of 68.1% (2012-2017), also ranking first in the world [5, 9].

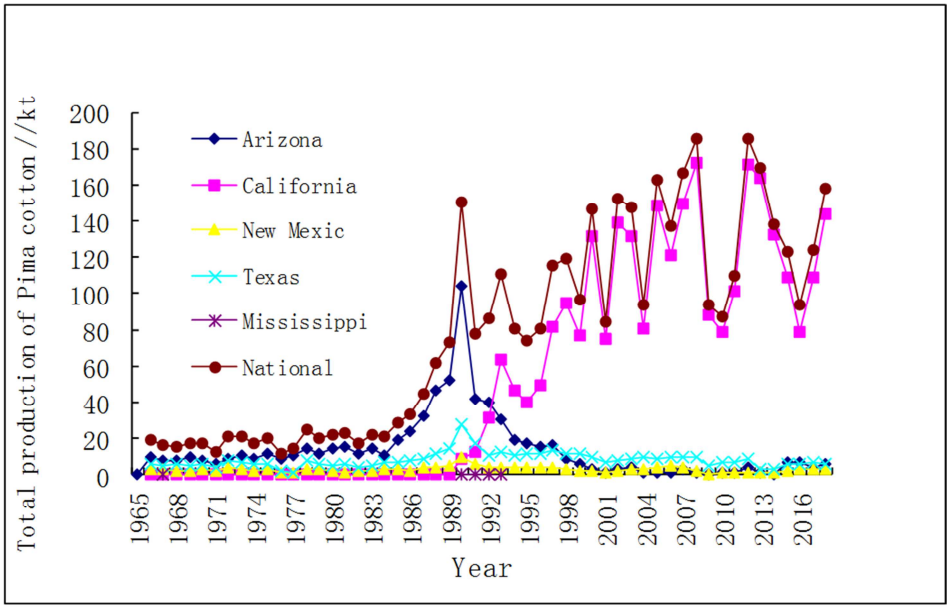

Figure 1. *The tendency chart of Pima cotton total production in the United States over the years.*

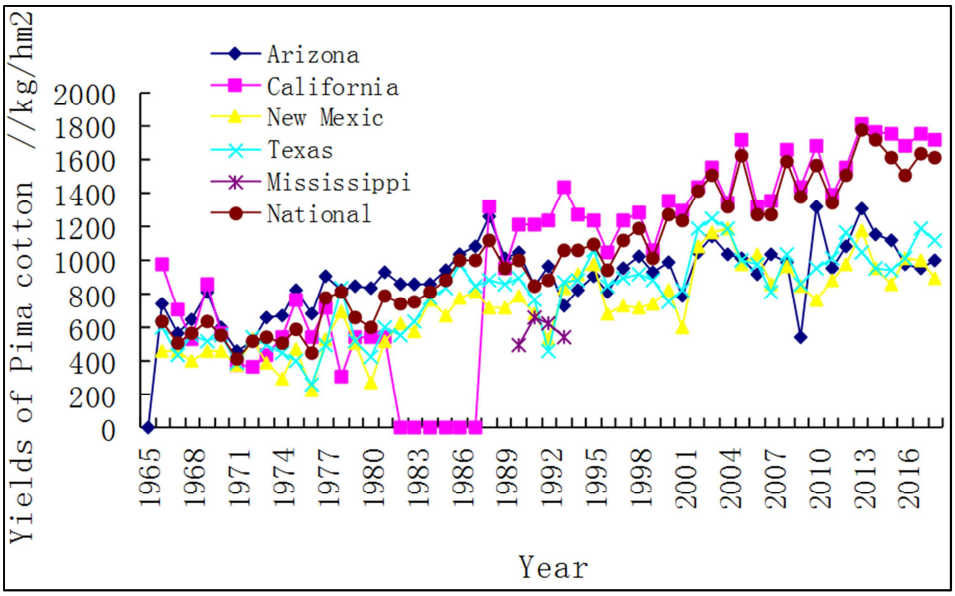

Figure 2. *The tendency chart of the yield of Pima cotton in the United States over the years.*

Table 2. *The production of Pima cotton in the United States from 2013 to 2017.*

State	Cotton region	Area //hm^2/year	Per unit area yield //kg/hm^2	Total yield // 10^4 t /year
Arizona	West	4856.2	1039.5	0.483
California	West	66206.6	1730.4	11.474
New Mexico	West	2428.1	941.1	0.231
Texas	Southwest	5503.7	1039.5	0.566
The United States*		78832.8	1613.1*	12.754

Table 2. *Continued.*

State	Proportion in total yield (%)	Rank	Note
Arizona	3.8	3	Centralized but not in large-scale, mainly planted in 2 counties of Graham and Pinal
California	90.0	1	Centralized, an unique state of ELS production in the United Stages, mainly planted in 3 counties of Kings, Fresno and Merced
New Mexico	1.8	4	Not centralized but sparsely planted
Texas	4.4	2	Not centralized
The United States*	——	——	Overall centralized

As shown in Figure 2, in addition to California, which had a record of per unit yield of 0 in the statistics of 1981-1986, the other states as well as the whole country show an upward trend of yield per unit of Pima cotton from 1965 to now, and the yield of all states are basically the same, but the major cotton producing states show significant advantage in the yield per unit. Among them, the highest yield per unit in 2013-2017 could reach up to 1 711.54 kg/hm^2, while the lowest reaching 1 504.18 kg/hm^2, with the average of the 7 years of 1 613.10 kg/hm^2, which is 1.7 times higher of the yield per unit of upland cotton over the same period, and 26.3% higher than the yield per unit of ELS cotton in China during the same period [5, 9].

The United States is the first country in the world to promote the inspection of cotton to the government authorized inspection agency, the United States Cotton Grading Center. Because of the standard inspection procedures, the test data has high public credibility in the world. The United States has achieved the bale-by-bale inspection to all produced Pima cotton, and the specific procedures are as follows: samples are taken by licensed sampler from cotton ginning corporations, and delivered to the Cotton Classing Office of the United States Department of Agriculture by specially-assigned-person, where the cotton is inspected timely according to the related procedures, and then the inspection results are innput to the National Cotton Inspection Database of the United States. Therefore, the inspection results can well represent the production quality of American cotton. Cotton planting farms (*i.e.* cotton owners) as well as the authorized users, including cotton ginning plants, cooperation, cotton purchasers as well as the textile factories can have access to the grading data timely from the database. In addition, the official website of the United States Department of Agriculture will issue the overall quality statistics of Pima cotton in the forms annual report, monthly report, weekly report and daily report. According to the Pima cotton quality report issued by the United States Department of Agriculture in 2015 and 2016, the Pima cotton produced in 2015-2017 has an average cotton grade of 1.7, leaf grade of 1.9, upper fiber length of 35.5 mm, fiber strength of 43.5 cN/tex, micronaire value of 4.1, uniformity of 86.0%, and the proportions of cotton color grade, upper fiber length, fiber strength, micronaire value and uniformity as well as the different value ranges are as shwon in Table 3. In short, the good production quality of American Pima cotton is shown in strong fiber strength, good micronaire value, proper uniformity, high color grade and leaf grade [10].

Table 3. *Production quality of Pima cotton in the United States.*

Index	Color grade	Leaf grade	Length of upper fiber //mm
Average	1.7	1.9	35.5
Note	First class accounting for 44.0%, second class 43.1	First class accounting for 33.5%, second class 51.8%, and third class for 12.4%	33.5-34.5mm accounting for 11.3%, and ≥34.7mm for 87.7%

Table 3. *Continued.*

Index	Strength // cN/tex	Micronaire	Uniformity // %
Average	43.5	4.1	86.0
Note	43.0 cN/tex accounting for 13.8%, 44.0 cN/tex 18.3%, 45.0 cN/tex for 40.0%	3.7-3.8 accounting for 14.8%, 3.9-4.0 25.8%, 4.1-4.2 for 26.7%	84.5-85.4 accounting for 18.1%, 85.5-86.4 for 43.8%，86.5-87.4 for 29.1%

2.2.2. Brand

Because American Pima cotton is of good quality, it has become a popular raw material for textile enterprises to produce high-grade cotton fabrics. The raw materials for many brands of cotton textiles are designated as Pima cotton, such as Ralph Lauren, WestPoint Home, Springs Wamsutta, Brooks Brothers, James Perse, Michael Stars, Bloomingdale, Nordstrom, Brooks Brothers, Lord & Taylor, Bed Bath and Beyond, Costco, Impetus and other hundreds of brands, which also include mainly international brands. To ensure that the raw materials of ELS cotton for textiles are high quality Pima

cotton, more than 150 brands in the world, such as 3X1, BANANA REPUBLIC, BROOKS BROTHERS, CASPER, CHRISTY, EVERLANE, LEVI'S, MACY'S, MICHAEL STARS, STANCE, TOMMY BAHAMA, JACK WILLS, STEVEN, CROCODILE, Lacoste, UNIQLO, SCHIESSER, DARREN PALMER, SNOOZE and so on, have been licensed by the Supima Association of America to designate to use PIMA cotton recognized by the Supima Association of America, and have the right to add the word "Supima" to the logo of the cotton textiles they produce. The international market recognition and status of USA Pima cotton are Accepted. At present, ELS cotton producers in the world are China, the United States, Egypt, of which the United States Pima cotton brand is the most influential.

2.3. Equipment and Technology

2.3.1. Equipment

The United States is the earliest country to carry out modernized intensive cotton planting and production, and it basically achieved the whole-process modernization of cotton planting at the end of 1960s and the beginning of 1970s, including all the planting, harvesting and processing links of soil preparation, sowing, fertilization, irrigation, pest control, harvesting, processing. The multi-functional, multi-type agricultural machinery in the market, especially the large-scale agricultural machinery with large power and highly automation, has advanced performances, high degrees of standardization, serialization and universalization, and it is easy, convenient and comfortable to use, which has been widely used and well popular in the United States in the cotton production process. Today, the vast majority of the world's cotton picker machine is made in the United States, and the newly developed cotton picker by the United States has realized the integrated operation of self walking, picking, loading, unloading, cotton module building, module unloading, which also has high picking rate and low loss rate, and it is recognized as the most advanced representative agricultural machinery in the world.

Table 4. *Planting conditions of ELS varieties in the United Stages in 2016.*

Cotton brand	Variety name	Planting ratio // %	Total planting ratio // %
Phytogen series	PHY 881 RF	58.9	74.9
	PHY 888 RF	7.7	
	PHY 841 RF	7.0	
	PHY 805 RF	0.7	
	PHY 802 RF	0.4	
	PHY 811 RF	0.2	
Hazera	HA 1432-Pima	14.1	14.3
	HA 690-Pima	0.2	
Deltapine series	DP 348	6.7.	9.6
	DP 357	2.9	

Table 4. *Continued.*

Cotton brand	Variety breeding company	Note
Phytogen series	Dow AgroSciences Ltd.	World famous agricultural enterprise, and the pioneer of Pima cotton breeding
Hazera	Hazera Seeds Company	Global leader of hybrid cultivar cultivation
Deltapine series	Monsanto Co., Ltd	Leading in global crop transgenic breeding, purchased by Bayern Chemi

Note: RF is a transgenic cotton cultivar resistant to glyphosate.

The United States has more than one international first-class high-tech agricultural enterprises, which ensure that the farmers in the country can use the most advanced materials and equipment, including high yield and pest-resistant variety, high-efficient new fertilizers with low pollution, new pesticides (including herbicides, pesticides, defoliation ripener, chemical regulator), all kinds of modern agricultural machinery, as well as advanced processing and testing equipment, all of which are first and widely used in the United States. For example, there are mainly 3 different variety brands in production, namely Phytogen (PHY), Hazera (HA) and Deltapine (DP), which account for 74.9%, 14.3% and 9.6% in the ELS cotton planting area in the United States in 2016. And there are respectively 6, 2,2 varieties of each brand applied in production. The above varieties are all have high yield, high quality and high adaptability. In 2016, the total planting area of the varieties under PHY brand was 55 896.12 hm^2, which had significant advantages over the other varieties in planting area and absolute scale of planting. The varieties of DP brand also have a good development momentum, and Hazera brand, as a provider of hybrid cotton, shows good prospects for development (Table 4) [11-17].

Further investigation indicates that: there were totally 18 ELS cotton varieties planted in 2015-2018, namely PHY 800, PHY 802 RF, PHY 805 RF, PHY 811 RF, PHY 830, PHY 841 RF, PHY 881 R, PHY 888 RFF, HA 211, HA1432-Pima, HA690-Pima, DP 340, DP 348 RF, DP 357, DP 358 RF, ATX P-203, Pima S-7. The main characters are shown in Table 5, in which RF is a transgenic cotton cultivar. As shown in Table 4&5, most of the varieties are middle mature or middle-late mature varieties, with the lint percentage of 35.2-38.5% (an average of 36.6%), micronaire value of 3.4-4.2 (an average of 3.9), fiber length of 34.1-37.1 mm (an average of 35.5 mm), fiber strength of 37-44.8 cN/tex (an average of 42.9 cN/tex), uniformity of 86.1- 87.5% (an average of 86.8%). Most varieties have resistance to the physiological race 4 of wilt, and the varieties with relatively larger planting areas are

transgenic varieties. To sum up, the Pima cotton varieties planted in the United States have good overall genetic quality, and general disease resistance. The Pima cotton yield throughout the United States proves the high yield property of these varieties. Therefore, the above varieties have good overall agronomic traits, which lay the necessary foundation for the Pima cotton production in the United States [16-18].

Table 5. *The cultivar names of Pima cotton planted in the Unites Stages in 2015-2018 and main characters parameters.*

Cultivar name	Maturity	Lint percent // %	Micronaire	Length // mm	Strength // cN/tex
PHY 805 RF	Middle-late	37.5	3.9	35.8	45.8
PHY 811 RF	Early-middle	36.7	3.9	36.6	44.7
PHY 881 RF	Middle mature	38.1	4.1	35.8	44.5
HA 1432-Pima	Middle-late	35.3	3.4	35.1	40.3
PHY 841 RF	Middle mature	38.5	4.2	35.8	45.6
PHY 802 RF	Middle mature	36.6	3.8	37.1	45.5
DP 358 RF	Middle-late	36.6	4.0	36.1	44.7
PHY 830	Early-middle	----	4.2	35.4	44.1
PHY 800	Middle mature	35.5	3.9	35.5	44.0
DP 348 RF	Middle mature	36.3	4.1	35.6	45.4
DP 357	Middle mature	35.7	4.0	35.2	39.6
DP 340	Middle mature	37.0	4.0	35.1	39.8
HA 211	Middle mature	35.2	3.7	34.0	38.0
P-203	Middle mature	36.8	3.9	35.1	39.8
S-7	Middle mature	---	4.0	34.2	42.0
Average		36.6	3.9	35.5	42.9

Table 5. *Continued.*

Cultivar name	Uniformity //%	Transgenic variety or not	Resistance to the physiological race 4 of wilt
PHY 805 RF	87.3	Yes	Resistant
PHY 811 RF	87.0	Yes	Resistant
PHY 881 RF	87.2	Yes	Resistant
HA 1432-Pima	86.0	--	Resistant
PHY 841 RF	87.5	Yes	Resistant
PHY 802 RF	87.3	Yes	Resistant
DP 358 RF	87.0	Yes	Highly resistant
PHY 830	87.0	No	Certain resistant
PHY 800	87.0	No	Highly resistant
DP 348 RF	86.5	Yes	Resistant
DP 357	86.7	No	Poorly resistant
DP 340	86.4	No	Poorly resistant
HA 211	86.1	No	Certain resistant
P-203	86.3	No	Poorly resistant
S-7	86.4	No	Certain resistant
Average	86.8		

2.3.2. Technology

The cotton varieties with 99.5% planting area in the United States currently are the monovalent or polyvalent transgenic cotton varieties with resistances to herbicides, insect agents and pesticides, in which Pima cotton transgenic cotton varieties account for about 80% of the total Pima cotton planting area.

The United States attaches great importance to complete set of cultivation technology of Pima cotton. For example, the high-efficient utilization of water, fertilizer and natural ecological resources as well as the integration of water, fertilizer and drugs, remote monitoring and control, simple and efficient cultivation, intelligent decision and organic Pima cotton production are in world's leading or high level. In addition, based on the positioning system, different cotton fields are conducted with different fertilization and irrigation management, which greatly improves the land and resources production rate. At present, most of the farms have been using the global positioning system to assist agricultural production, and farmers have been achieved targeted farming operations through remote operation of agricultural machinery. Differential GPS can achieve the positioning accuracy at "cm" level, and this technology has been applied to a large area of soil protection, biochemical pest prevention, soil testing and fertilization and other farming operations in the cotton field, which create conditions for the fine management of American Pima cotton. In this process, universities and research institutes actively help the farms to collect and collate the agricultural basic data of different plots, varieties, yield, fertilizers and humidity conditions, so as to constantly improve the mechanical operation and intelligent decision making. In addition, the United States also has systematic and mature measures in terms of conventional techniques like crop rotation, soil texture improvement, irrigation and fertilization, density setting, population control (including mepiquat chloride regulation), defoliation ripening and pests prevention. For example, in actual production, cotton is planted in succession with processed tomato or wheat or corn or alfalfa

or onions or garlic, and deep plowing once every three years at the depth of 60-90 cm. Experiment and demonstration has clarified that under the 76 cm equal spacing planting conditions, the best plant population is 97 500 - 135 000 plants/hm^2, with water consumption of 7 500 - 10 500 m^3/hm^2, and mepiquat chloride should also be sprayed to American Pima cotton, usually once at the end of June-early and middle July and at the end of July- early August. In order to ensure the timely mechanical picking, the spraying intensity of ripening defoliant for Pima cotton is larger than that for upland cotton, and picking for 1-2 times. The specific picking times is determined by the variety, climate and cotton field management. In order to reduce the harm of pests and weeds, in addition to crop rotations and regular ultra deep plowing, it also promotes timely application of integrated pest control technology (IPM) [19].

In short, the modernized material equipment and the advanced and practical technologies make the United States become the model of modern and efficient agriculture, and the other cotton producing countries in the world all are learning from the cotton production technologies in the Unites States.

2.4. Planting Distribution and Production Organization Form

2.4.1. Distribution

With a long history of cotton planting, the United States is the largest cotton planting country in the world, and its overall cotton planting regional layout is stable. Up to now, there are 17 states planting cotton, in which 4 states plant Pima cotton, accounting for 23.5% of the total cotton planting states. The planting scale and production amount of Pima cotton is in the order from large to small of California, Texas, Arizona and New Mexico. 3 of the Pima cotton planting states are in the west cotton producing area, one in the southwest cotton producing area. The Pima cotton production in west cotton producing area accounts for 95.6% of the total throughout the United States, and the annual Pima cotton production of California accounts for as high as 90.0% of the total in the United States, while the state with the smallest Pima cotton production only accounts for 1.8% of the total. The production of the state with the largest amount is 49.7 times larger than that with the smallest amount, and the production of state with the largest production amount is 10.0 times larger than the total cotton production amount of the other 3 Pima planting states (Table 2) [4-5].

Further analysis shows that there are only 5 counties recorded in the government statistical yearbook that plant Pima cotton. Among them, 3 countries are in California, all located in SJV area, accounting for 37.5% of the total number of counties in SJV. In terms of the planting scale and yield, the 3 Pima cotton planting counties are in the descending order of Kings, Fresno, Merced, the planting scale and yield respectively accounting for 38.4%, 25.2%, 7.8% and 39.8%, 28.9%, 7.6% of those in the United States. In addition, the 3 Pima cotton growing counties is centered with Fresno, with Kings in the south by east, Merced in thenorth. Kings and Fresno are the 2 counties mainly planting ELS cotton, and the total production amount of the 2 counties accounts for 68.7% of the total in the United States, while the other county, Merced, mainly plants with upland cotton. Among the 3 counties, the planting scale of Pima cotton accounts for 71.4% of the whole country, while the production accounts for 76.8% of the total. There are 2 Pima cotton planting counties in Arizona, namely, Graham and Pinal, and the annual production of the 2 counties accounts for 2.3% and 1.1% of the country, which is a quite small proportion. Moreover, both counties mainly plant upland cotton. Therefore, it can be fully recognized that SJV is the centralized Pima cotton planting area in the United States, where the planting area is very concentrated. Although the area is not large, SJV is well-known for planting Pima cotton and Acala quality cotton (Figure 3, Table 2 & 6) [9].

2.4.2. Production Organization Form

The cotton production in the United States (including upland cotton and Pima cotton) is organized based on farms, which not only include family farm, but also corporate farms (including joint-stock corporate farms). The farm owners select the farm organization form according to the size of the farms and other specific situations by their own. Generally speaking, small farms are family farms, while large and medium scale farms, especially large scale farms are corporate farms and joint stock corporate farms. The existing data can only show that the scale of a single Pima cotton planting farm at present is larger than the average scale of the cotton planting farms throughout the United States, but there is no accurate data about the specific scale of a single Pima cotton planting farm. However, it is certain that the average scale of each cotton planting farm is 250 hm^2, which is still in the increasing trend, that is to say, the scale of a single Pima cotton planting farm is greater than 250 hm^2, which is about 50% larger than the average scale of all farms in the United States. The adoption of farms as the production organization form ensures that the farm owners have completely independent management right, and thus they have the rights to choose the types of crops and cropping systems, but sometimes in order to get more government subsidies, or considering the ecological and sustainable production and other policy factors, they will make proper adjustment to the planting structure. Investigation shows that these farms use modern intensive farming operation mode with large scale agricultural machinery operation, and there is a super large cotton farm which is specially planted Pima cotton in SJV, called J.G. Bosewll Company. The farm crosses both Kings and Kern, but most part of the farm is in Kings. The annual Pima cotton planting area in the farm is over 20 000 hm^2, the peak season can reach over 30 000 hm^2. It is the largest cotton farm in the world, and also the largest ELS cotton farm in the world, which has a great international influence [5, 9].

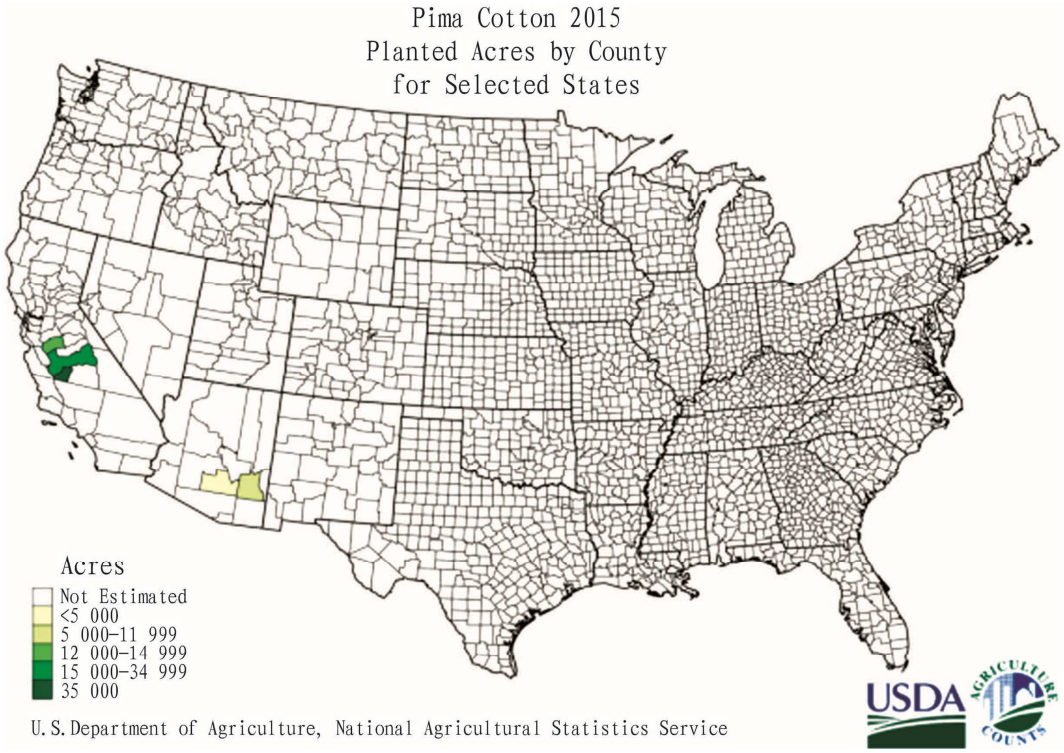

Figure 3. *Pima cotton growing areas in the United States.*

Table 6. *Yield per unit area of Pima cotton in the United States in 2012-2016.*

County	Corresponding stage	Cotton area	Area// hm^2/year	Yield per unit // kg/ hm^2	Total yield //10^4t/year
Kings	California	West	30189.6	1710.5	5.172
Fresno	California	West	19740.6	1887.6	3.755
Merced	California	West	6097.3	1623.0	0.990
Pinard	Arizona	West	1487.2	987.8	0.148
Graham	Arizona	West	2848.0	1076.8	0.291
Other counties	California	West	7830.7	1558.1	1.270

2.5. Scale Benefits

As shown in Figure 4, American Pima cotton was in a wandering situation in 1965-1986, and turned into a rapid expansion situation in 1986-1989, and then has presented an overall high position wandering situation since 1990.

According to the data provided by the United States Department of Agriculture and the University of California Cooperative Extension, the production cost of the cotton planting areas in the west is high, and the production cost for Pima cotton and Acala cotton is even higher. Since there is no seed cotton sales market in the United States, the income of farms comes from the sales of lint cotton and cottonseeds. The production cost of the lint cotton and cottonseed of Pima cotton is composed of the direct production cost and the management fees. The direct production cost of Pima cotton includes the cost in cotton planting, harvesting and cottonseed processing, the main details include seeds, fertilizers, pesticides, fuel purchases, as well as all kinds of farming operation (soil preparation, sowing, plant diseases, pests and weed control, chemical regulator and defoliant spraying, cottonseed harvest), irrigation, vehicle use fees, labor cost, transportation, lint cotton processing (including cottonseed transportation), equipment and facilities maintenance. Management fees mainly include facilities and equipment depreciation, capital investment interest, sharing fees for the uniform implementation of the planting area, detection fees, consulting fees, various insurances (insurance and property insurance), property tax, office expenses, basic farmland facilities and equipment repair cost, and the details in facilities and equipment depreciation mainly include field pipeline, field irrigation facilities, buildings, oil storage tanks, farm vehicles and so on. As shown in Table 7, the production cost for American Pima cotton over the years is \$4 760-4 950/hm^2, with an average of \$4 840/hm^2, so the cost is high. And the items with the proportion in production cost from high to low are facilities and equipment depreciation (mainly including field facilities and equipment depreciation), irrigation, mechanical operation (mainly including fuel and mechanical maintenance), lint cotton processing, fertilizer input, labor employment, pesticide use, employees, property tax, herbicides application, defoliation ripener utilization, seed purchase, respectively accounting for 25.8%, 12.5%, 10.6%, 9.0%, 7.5%, 6.1%, 5.9%, 4.4%, 3.2%, 3%, 2.7% of the production cost, and the total proportion of the above mentioned items is 90.7% [19-20].

The per unit yield of lint cotton, per unit yield of cottonseed, price per unit of lint cotton and price per unit of cottonseed can be obtained from the official site of the National Agricultural Statistics Service of the United States Department of Agriculture, and the product value is $5 143-7 041/hm^2, with an average of $5 864/hm^2 [9, 19-20].

Table 7. *Benefit analysis of Pima cotton in the Unites States in 2011-2015.*

Year	Production cost //$/ hm^2)	Proportion of selling cost in product value // %	Per unit yield of Pima cotton // kg/ hm^2	Unit price of Pima cotton//$/t)
2012	4950	8%	1772	2730
2013	4820	8%	1710	3680
2014	4860	8%	1604	3310
2015	4810	8%	1503	3020
2016	4760	8%	1578	3240
Average	4840	8%	1633	3196

Table 7. *Continued.*

Year	Cotton seed yield per unit area // kg/ hm^2)	Cotton seed price per unit area //$/t	Product value //$/hm^2	Net income //$/ hm^2
2012	3130	252	5626	226
2013	3030	247	7041	1658
2014	2840	194	5860	531
2015	2660	227	5143	-79
2016	2790	194	5654	442
Average	2890	223	5864	555

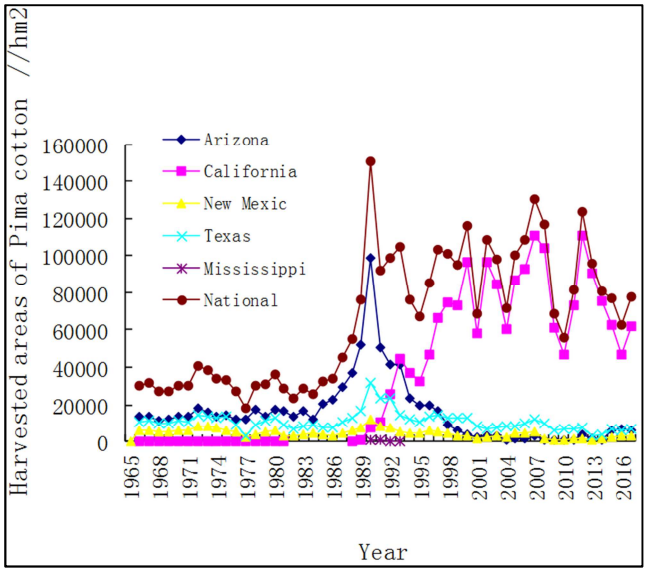

Figure 4. *The tendency chart of Pima cotton planting area in the United States over the years.*

Total cost = Production cost + Cost of sales, in which the cost of sales refers to the various expenses for the sales of lint cotton and cottonseed. The cost of sales is counted according to 8% of the sales amount, that is, 8% of the product value, which mainly includes warehousing fees, handling fees, loss, taxes, intermediary fees, personnel fees and other shared management fees [19-20]. Thereby, the average total cost is $5 309/hm^2. The net income of farm owner = Product value – Planting cost – Cost of lint cotton sales, in which the product value is the sum of lint cotton and cottonseed sales. The final net income of the farm owner is -79-- $1658/hm^2, an average of $555/hm^2. Assume the cotton planting area of each cotton farm is 250 hm^2 on average, excluding any subsidies from the American government, the net income of each farm can reach up to $137 500 on average, which shows high scale benefit (Table 7).

2.6. Social Services

In addition to government agencies and support of the relevant departments, including universities, research institutes, the accomplishment of social services mainly relies on corporations and social groups, and the socialized services in the United States have achieved high degree of specialization and marketization. Because of the good market economy environment, strong awareness of scientific and technological innovation, many well-known companies have participated in the research and development, production and operation of the Pima cotton material equipment and related technologies in the United States, including seeds, agrochemical, agricultural machinery, cotton processing, inspection and quality management and other equipment manufacturing companies, such as Dow Chemical Company, Dow AgroSciences, Monsanto Company, Bayer AG, Hazera Seed Inc, Deere & Company of the United States, CNH Industrial America LLC., Case/New Holland NV, Lummus Corp, Continental Eagle Pty Ltd., the Swiss Uster Technologies. There are also a lot of world-class multinational companies, which play a leading and vanguard role in their respective fields of research and development, and they have the absolute right to speak in the field. Their products have obvious monopoly, which play a leading role in promoting the planting of American Pima cotton. For example, Dow AgroSciences succeeded in combining bio engineering and molecular breeding techniques with conventional breeding, and its transgenic Pima cotton varieties with pest and herbicides resistance have been used in large scale production. Moreover, Dow AgroSciences together with Monsanto Company and Hazera Seeds Ltd. has completely monopolized the production seeds of American Pima cotton, and the

planting area of the Pima cotton variety of Dow AgroSciences reached up to 72.7% of the total Pima cotton planting area in the United States [11-15].

There are a number of social groups, the ones with great influences mainly including San Joaquin Valley Cotton Board, Supima Association of America, National Cotton Council of America, California Cotton Growers and Ginners Association and Pima, as well as the various cooperatives related with agricultural materials purchase, agro-mechanization services and finances of Pima cotton planting in the local places, and Cotton Incorporated, Cotton USA. These social organizations not only provide professional services in all aspects of cotton planting, harvesting and processing, achieving the use of phone to work out the materials, technologies and various complicated farm operations required for cotton field, including the supply of agricultural production materials before planting, land plowing, sowing, fertilizing, pest control, weeding, harvesting during the production, and transportation, processing, packaging, inspection, selling and storage after production, but also provide the farm owners with the technical services and information sharing as well as the relevant legal protection before, during and after cotton production, as well as lobby the government to strengthen the policy support of Pima production. Although many of these are paid services (some even cost a lot), farmers have their own rights to choose. For example, the standard fee charged for each bale of cotton is $3 by the Supima Association of America [2, 4, 19].

The role of social groups is explained with Supima Association of America as an example. Supima is a non-profit organization in the United States whose main objective is to promote the use of American Pima cotton. The association actively participates in Pima cotton quality guarantee and intellectual property protection, and through many years of market operation and publicity, it is ensured that its certified Pima cotton is a high-quality kind of ELS cotton, and it has clarified that only Pima cotton is the assigned cotton for Supima marker, and any products labeled Supima® must use the Pima cotton recognized by the association, not any other ELS cotton substitutes, which make Pima cotton or textiles marked with Supima® become the world recognized symbol of world top grade cotton goods. It creates a unique demand in world's textile factory, brand manufacturers and retailers, greatly improving the popularity of American Pima cotton. Since the Supima brand is recognized by the market, the association in turn has the right to license the use of the Supima trademark to top spinning mills, knitting mills, fabric mills, garment factories, brands and retailers. At present, more than 150 brands have authorized the use of Supima trademark globally. Supima brand has covered shirts, sheets and towels, and even extended to luxury women's knitwear, base model knitted T-shirt, denim fabric and other products, greatly improving the consumption of American Pima cotton in the world.

In order to effectively prevent counterfeiting, Pima cotton efficient identification and anti-counterfeiting technology was first developed by One of DNA research and development company in the United States, which eliminate the use of other ELS cotton substitutes for cotton textiles labeled Supima or Pima, which creates a more favorable and reliable market sales environment for America Pima cotton farmers and dealers. Therefore, the interests of American Pima cotton farmers have been effectively protected [2].

2.7. Policy Support

The United States achieves the policy support for Pima cotton through the provisions of laws. According to the Agricultural Act of 2014, the scope of policy support can be divided into cotton special support policy and general support policy. The so-called special support policy is support measures only given to cotton (Pima cotton), while general support policy means the policy is not only applicable for cotton, but also for other crops or other agricultural production and operation. Cotton special support policy mainly includes Cotton Special Insurance Subsidy, and Special Competitive Provisions for Extra Long Staple Cotton. Cotton Special Insurance Subsidy refers to the Stacked Income Protection Plan for Producers of Upland Cotton (STAX) and Supplemental Coverage Option (SCO) proposed by the new Agricultural Act, where SCO is the most important cotton support policy for the farm owners in the United States. Special Competitive Provisions for Extra Long Staple Cotton stipulates that when the lowest priced competing growth of world ELS price is lower than $2.36/kg (106.89 cents/lb), it will offer subsidies to the consumers or exporters of American ELS cotton, so as to promote the production of ELS in the United States and maintain the strong international competitiveness of American ELS cotton [21-24].

General support policies include basic insurance payments, loan supplying payments, cotton export credit guarantee, farm infrastructure investment, and the supporting policies promoting rural development subsidies, new agricultural equipment, application support for the research, development and extension of new varieties and related new technologies, financial support, tax incentives and environmental protection. The loan supplying payments refer to the subsidy refers to the Commodity Credit Corporation Loan (CCC) provided to cotton (including upland cotton and ELS cotton) growers by the staple agricultural loan / acquiring company under the direct management of the Agricultural Marketing Service of the United States Department of Agriculture. According to the provisions in CCC, the farmers can ask for a loan at the benchmark price of Pima cotton $1.76/kg ($0.797 7/lb). Before the loan due, if the market price is higher than the sum of benchmark price, interest and storage cost, farmers can redeem their cotton and sell it on the market on their own, and then repay the loan, interest and storage cost; if the adjusted prevailing world price (AWP) is lower than the sum of benchmark price and interest, cotton growers can mortgage the cotton to the loan company, and the United States Department of Agriculture will compensate the insufficient part of the loan according to the loan base price (*i.e.* loan supplying payments), to ensure that the cotton growers can get

the sales amount that is equal to the sum of the loan benchmark price and interest [21-24].

The education, research and technology extension have always been an important part of the governmental duties of the United States, and therefore, the government has clarified that cotton technology extension is mainly in the charge of the state universities, which are responsible to organize cotton technology extension centers of cotton extension steering committees at county level to carry out timely assessment, supervision and guidance to the cotton technology extension in the local places, effectively improving the cotton technological level in the United States.

The financial supporting policies of the United States mainly include the the implementation of separating support from the policy financial institutions, cooperative financial institutions, commercial financial institutions, private lending organizations and cotton insurance, so as to ensure that the United States has a sound financial system in cotton industry, thereby forming a long-term mechanism with virtuous cycle of cotton industry funds. The multi-level, multi-channel loan support from these financial supporting policies can satisfy the needs of cotton companies or family farms on production capitals. For example, the policy financial institution CCC is responsible for providing loans to farmers to solve the problem of lack of funds during harvesting, and help farmers do a good job of storage and sales. The government allows farmers to form partnerships with private banks, thereby making it convenient for farmers to make bank deposits and loans as well as reducing financial cost [4, 24].

In order to ensure the quality of American Pima cotton, promote fair trade, the United States government provides farmers with mandatory payment service of fiber quality testing services. At present, the United States Department of Agriculture has set up cotton testing organizations in Abilene, Corpus Christi, Dumas, Florence, Lamesa, Lubbock, Macon, Memphis, Rayville, Visalia, and these testing organizations are distributed across the different major cotton producing regions, in which Visalia cotton testing center is located in the Pima cotton producing region in SJV, mainly in charge of the quality inspection of Pima cotton.

The system supporting policies of the United States not only reduce the market risks of farmers, operators and users, but also stabilize the income of farmers and operators, thereby promoting the continuous production of American cotton, which in turn improve the competitiveness of American cotton in international market, and consolidate the status of the United States as the powerful cotton production and trading country, including Pima cotton [21, 24].

3. Conclusions

The American Pima cotton production has superior advantages in natural ecological conditions, yield, quality and brand, material equipment and technology, planting layout and production organization form, planting scale benefit, policy and social services. Further analysis shows that the natural ecological conditions and planting layout provide the platform, material equipment and production organization form offer the measure guarantee, policy and social services can fully play to a lot of potential advantages, and yield, quality and brand as well as benefit are the performances of the advantages.

The main agronomic traits and genetic qualities of Pima cotton varieties are as follows: most of the varieties are middle mature or middle-late mature varieties, with the average lint percentage of 36.6%, average micronaire value of 3.9, average fiber length of 35.5 mm, average fiber strength of 42.9 cN/tex and average uniformity 86.8%. Most varieties have resistance to the physiological race 4 of wilt, and the varieties with relatively larger planting areas are transgenic varieties. Although the varieties have general resistances to diseases, the Pima cotton farmers in the United States pay great attention to crop rotation and periodic deep plowing, so there is no report on the yield reduction caused by poor disease resistances. The actual production practice not only proves the advantages of the superior genetic qualities of the varieties, but also shows their good high yield performances. Therefore, the Pima cotton varieties have overall good agronomic traits, which ensure the large scale Pima cotton production in the United States.

All the American Pima cotton is harvested by machine. Although mechanical plucking greatly reduces cotton planting cost, the average production cost is still high, reaching up to \$4 840/hm^2. The high cost is mainly due to the high cost in facilities and equipment depreciation (mainly including field facilities and equipment depreciation), irrigation, mechanical operation (mainly including fuel and mechanical maintenance fee), pesticides application, lint processing (including cottonseed transportation), fertilizer input, and facilities and equipment depreciation, irrigation, mechanical operation, lint cotton processing (including cottonseed transportation), fertilizer input respectively account for 25.8%, 12.5%, 10.6%, 9.0%, 7.5% of the production cost. There is no doubt that in addition to related with the cotton production cost, including lint cotton processing (including cottonseed transportation), which costs a lot, the high cost is also related with the calculation way of Pima cotton production cost, which is calculated completely according to the cost accounting model of western industrial products, including capital cost, opportunity cost, unpaid labor cost and various types of management and allocation cost.

At present, there are mainly 3 series of ELS cotton, namely American Pima cotton, Chinese Xinhai cotton, Egyptian Giza cotton. The American Pima cotton has an annual production of 127 540 t, which is not very high, but compared with other ELS cotton producing countries, its production ranks the top, accounting for 37.6% of the total ELS yield in the world (2012-2017). The exports of American ELS cotton account for 68.1% of the average total exports in the world (2012-2017). Most importantly, although the production cost of American Pima cotton is high for unit area (benefit per unit area is only \$555/hm^2), which shows high scale benefits, so the production organization form is reasonable, and together with the fact

that the American Pima cotton is the ELS cotton with high price, stable quality, customer trust, best brand effect in the world, excluding the various subsidies from the government, the net income can reach up to $140 000 for a farm with the Pima cotton scale of 250 hm^2, so the scale benefits are significant. Therefore, it is firmly affirmed that American Pima cotton achieves the synchronization target for high yield and high quality with high scale benefits, which is a typical case of successful ELS cotton production. In addition, the American Pima cotton breaks the "extensive cultivation with poor harvest" situation, which is common in the planting industries of the developed countries. Moreover, the United States is the world's first powerful cotton planting country to realize the bale-by-bale inspection of cotton produced by farm owners in the related institutions authorized by the government, and the standard inspection procedure and reliable data are helpful for the establishment of "high quality good price" market environment, thereby promoting the production of Pima cotton. In short, the United States is the largest and most powerful ELS cotton producing country, which has a prominent status in ELS planting industry in the world.

The United States is making unremitting efforts to make Pima cotton achieve international monopoly, including the importance attached to the technological innovation strategy from the national level, as well as the cooperations with the branding business at home and abroad, especially the top-grade cotton textile brands, which have won the special supply for the big cotton textile companies, ensuring that the American Pima cotton has become the sole supplier of many brands, including international brands of textiles. In order to prevent other ELS cotton replacing American Pima cotton as the raw materials of designated brands, an American company pioneered Pima cotton efficient identification and anti-counterfeiting technology, which realizes the identification of Pima cotton in the international textile market, further strengthening the monopoly. However, it is very unfavorable for other ELS cotton producing countries, and it is worth discussing whether the practice is a violation of international trade.

Funding

This work was supported by the Special Project for the Key Research and Development in the Xinjiang Uygur Autonomous Region (2016B01001-2); the Special Fund for Agro-Scientific Research in the Public Interest of the Ministry of Agriculture of China (201503117); the Project for Enriching People and Strengthening County of the Ministry of Science and Technology of China; the China Agriculture Research System for Cotton (CARS-18-07); the Special Fund for the Commercialization of Research Findings of the Xinjiang Uygur Autonomous Region (201354103); the Key Laboratory for the Physiological Ecology and Cultivation of Desert Oasis Crops, the Ministry of Agriculture of China.

References

[1] Wikipedia. *Gossypium barbadense* [DB/]. https://en.wikipedia.org/wiki/Gossypium_barbadense/, 2017-2-28.

[2] Supima Association of America. Frequently asked questions [DB]. http://www.supima.com/whats-supima/faq/, 2017-3-12.

[3] TIAN LW, CUI JP, GUO RS. Research on history review and actuality analysis of ELS cotton production in Xinjiang [A]. Essay Compilation of the 2016 Cotton Annual Meeting, Society of Agronomy [C]. Anyang: China Cotton Magazine House, 2016: 30-36.

[4] TIAN LW, CUI JP, XU HJ. The analysis of present situation on the production of US long-staple cotton [J]. World Agriculture, 2013, (9): 105-110.

[5] United States Department of Agriculture Economics, Statistics and Market Information System, Cotton and Wool Yearbook [DB]. http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1282/, 2017-3-12.

[6] San Joaquin soil [DB]. http://en.wikipedia.org/wiki/San_Joaquin_,2016-11-13.

[7] The San Joaquin Valley Climate [DB]. http://en.wikipedia.org/wiki/San_Joaquin_Valley, 2017-2-22.

[8] Climate data for Fresno. California [DB]. http://en.wikipedia.org/wiki/Fresno,2012-1-05.

[9] National Cotton Council of America. Cotton Crop Databases [DB]. http://www.cotton.org/econ/cropinfo/cropdata/index.cfm, 2017-3-12.

[10] The Agricultural Marketing Service (AMS). USDA, Market News, Cotton [DB]. https://www.ams.usda.gov/market-news/,2017-3-12.

[11] Wikipedia. Dow Agro Sciences [DB]. https://en.wikipedia.org/wiki/Dow_AgroSciences, 2016-11-18.

[12] Wikipedia. Monsanto [DB]. https:// https://en.wikipedia.org/wiki/Monsanto, 2017-3-10.

[13] Monsanto Company. About deltapine [DB] http://test.deltapine.com/About-Us/Pages/About-Us.aspx, 2017-3-12.

[14] Bayer: science for a better life. Overview [DB]. https://www.bayer.com/, 2017-3-1.

[15] HAZERA SEEDS INC. Who We Are [DB] http://www.hazera.com/, 2017-3-13.

[16] U. S. Department of Agriculture. United States 2015 Crop [DB]. https://search.ams.usda.gov/mndms/2015/09/CN20150915AVAR.pdf, 2017-3-13.

[17] U. S. Department of Agriculture. United States 2016 Crop [DB]. https://www.ams.usda.gov/mnreports/cnavar.pdf, 2017-3-13.

[18] University of California, Division of Agriculture and Natural Resources. Variety Selection (Variety Trials) [DB]. http://cottoninfo.ucdavis.edu/Variety_Selection/, 2017-3-13.

[19] University of California, Division of Agriculture and Natural Resources. Cost Studies [DB]. http://cottoninfo.ucdavis.edu/Cost_Studies/,2017-3-13.

[20] United States Department of Agriculture. Commodity Cost and Returns [DB]. https://www.ers.usda.gov/data-products/commodity-cost-and-returns.aspx, 2016-12-14.

[21] Agricultural Act of 2014 (2014 Farm Act) [DB]. http://www.gpo.gov/fdsys/pkg/BILLS-113hr2642enr/pdf/BILLS-113hr2642enr.pdf.

[22] Agricultural Act of 2014: Highlights and Implications.

[23] 2015 Crop Policies and Pilots [DB]. http://www.rma.usda.gov/policies/2015policy.html

[24] Research Group of the Ministry of Agriculture. Amendments of American Agriculture Bill in 2014 and the enlightenments to China [J]. Farm Produce Market Weekly, 2014, (19): 53-60.