# Analysis of influencing factors of raw cotton quality and prospect of optimisation pathway

**DOI: 10.35530/IT.075.04.202395**

JUNYANG WANG
LIMIN ZHANG
JINCHAN ZHANG
WANXIN WANG
HONG XU

**ABSTRACT – REZUMAT**

**Analysis of influencing factors of raw cotton quality and prospect of optimisation pathway**

*The paper discusses the issue of raw cotton quality and summarises it in the context of the current state of research. The article highlights the importance of cotton seeds for improving cotton quality and points out the problems in cotton seed selection and breeding. The article also mentions other factors affecting cotton quality, such as planting technology, light factors, defoliation and ripening technology, anisotropic fibre content and cotton picker operation quality. Based on these findings, ways to optimize the quality of raw cotton are proposed, including exploring suitable cotton varieties for machine picking, mitigating differences in raw cotton quality due to differences in geographic location and climatic conditions, and optimizing the use of picking techniques and processing machinery to reduce the impact on raw cotton quality. In conclusion, the paper provides a useful reference for promoting the application of cotton mechanical picking technology.*

***Keywords:*** *cotton seed, cultivation, fibre quality*

**Analiza factorilor de influență ai calității bumbacului brut și perspectiva metodei de optimizare**

*Lucrarea dezbate problema calității bumbacului brut și o rezumă în contextul stadiului actual al cercetării. Articolul evidențiază importanța semințelor de bumbac pentru îmbunătățirea calității bumbacului și subliniază problemele în selecția și cultivarea lor. Articolul menționează, de asemenea, alți factori care afectează calitatea bumbacului, cum ar fi tehnologia de plantare, lumina, tehnologia de defoliere și coacere, conținutul de fibre anizotrope și calitatea operațiunii de culegere a bumbacului. Pe baza acestor constatări, sunt propuse metode de optimizare a calității bumbacului brut, inclusiv explorarea soiurilor de bumbac adecvate pentru culesul mecanizat, atenuarea diferențelor de calitate a bumbacului brut din cauza diferențelor de localizare geografică și condițiilor climatice și optimizarea utilizării tehnicilor de cules și procesarea tehnologică, pentru a reduce impactul asupra calității bumbacului brut. În concluzie, lucrarea oferă o referință utilă pentru promovarea aplicării tehnologiei de recoltare mecanică a bumbacului.*

***Cuvinte-cheie****: semințe de bumbac, cultivare, calitatea fibrei*

## INTRODUCTION

In 2021, the domestic cotton planting area exceeded 45 million mu, with a total cotton output of 5.7 million tons. As shown in table 1, the cotton planting area in the Xinjiang region (subsequently recorded as XJr) was 2.5 million hectares, with an output of about 500 tons, whose share was more than 80%. The National Agricultural Mechanization Statistical Bulletin issued by the Department of Agricultural Mechanization Management in August 2022 [1] shows that, by 2021, the comprehensive mechanization rate of cotton in China has reached 87.25%, the mechanical harvesting rate of cotton in XJr has exceeded 80%, and cotton production has accounted for more than 85% of China's total cotton production. According to the China Agricultural Machinery Industry Association data, The cost of machine-picking cotton is reduced by 1.5 RMB per hectare compared to the labour cost, reducing the cost per mu of machine-harvested cotton by approximately 520 RMB. As a result, it can save about 60% on costs. Cotton cultivation in XJr is concentrated, with a large area and limited human

Table 1

XINJIANG COTTON PRODUCTION AND NATIONAL SHARE, 2016–2023

| Item | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|
| Total output (tons) | 407.8 | 456.6 | 511.1 | 500.2 | 516.1 | 512.9 | 539.1 |
| Share of the country (%) | 76.3 | 80.8 | 83.8 | 84.9 | 87.9 | 89.5 | 90.2 |

*Source*: Statistical Bulletin of the National Economic and Social Development of the Autonomous Region.

resources, so the comprehensive mechanization of various processes in XJr cotton has become an inevitable trend [2]. In the face of expanding cotton production and the increasing demand for high-quality lint in the market, the cotton industry needs to continuously improve and innovate in various aspects, such as cotton seed cultivation, cotton planting, cotton harvesting, warehousing, and processing, to actively adapt to the current situation and trend of machine picked cotton processing, as well as further improve the quality of raw cotton.

## FACTORS AFFECTING THE QUALITY OF RAW COTTON

By analysing the current research results involving raw cotton quality, it can be obtained that the main factors affecting the quality of raw cotton are as follows:

### Cotton seed selection with multiplicity and heterogeneity

The two relatively important factors affecting the quality of raw cotton are cotton varieties and cotton processing technology [3]. The selection of cotton varieties, especially for the different harvesting and processing techniques, is important to improve the overall quality of cotton fibres. As shown in table 1 and figure 1, XJr's major cotton production areas and climatic environments are complex, especially with significant differences in climate between the north and south of XJr [4]. Some areas have shorter frost-free periods, the cotton growing season is limited, and the growth of cotton is greatly influenced by these natural conditions.

As shown in table 2, in recent years, XJr has applied for dozens of cotton varieties to be approved by the state, and the varieties approved by the autonomous region are more diverse. Therefore, the selection of cotton varieties in various regions has shown a “multiplicity and heterogeneity” state. As shown in figure 2, from the overall quality perspective, more than half of the cotton varieties selected by the main cotton-producing areas have a seed length of less than 31 mm and a fracture ratio strength of less than 31 cN/tex. The fibre length and specific strength of cotton have shown a trend of recovery, but the genetic quality of the cotton varieties currently being promoted is still insufficient [5–8].

At present, research on cotton seed mostly focuses on the aspects of cotton yield and fibre quality, including seed cotton yield, lint yield, boll weight, fibre strength, fibre length and fibre fineness. But the suitable cotton seeds for mechanized picking have higher requirements for plant height and bolls concentrated spitting flocculent. There are currently no reports of cotton varieties suitable for machine harvesting in XJr, and there is relatively little research on cotton varieties suitable for machine harvesting, too. There is still a lot of room for research [9, 10].

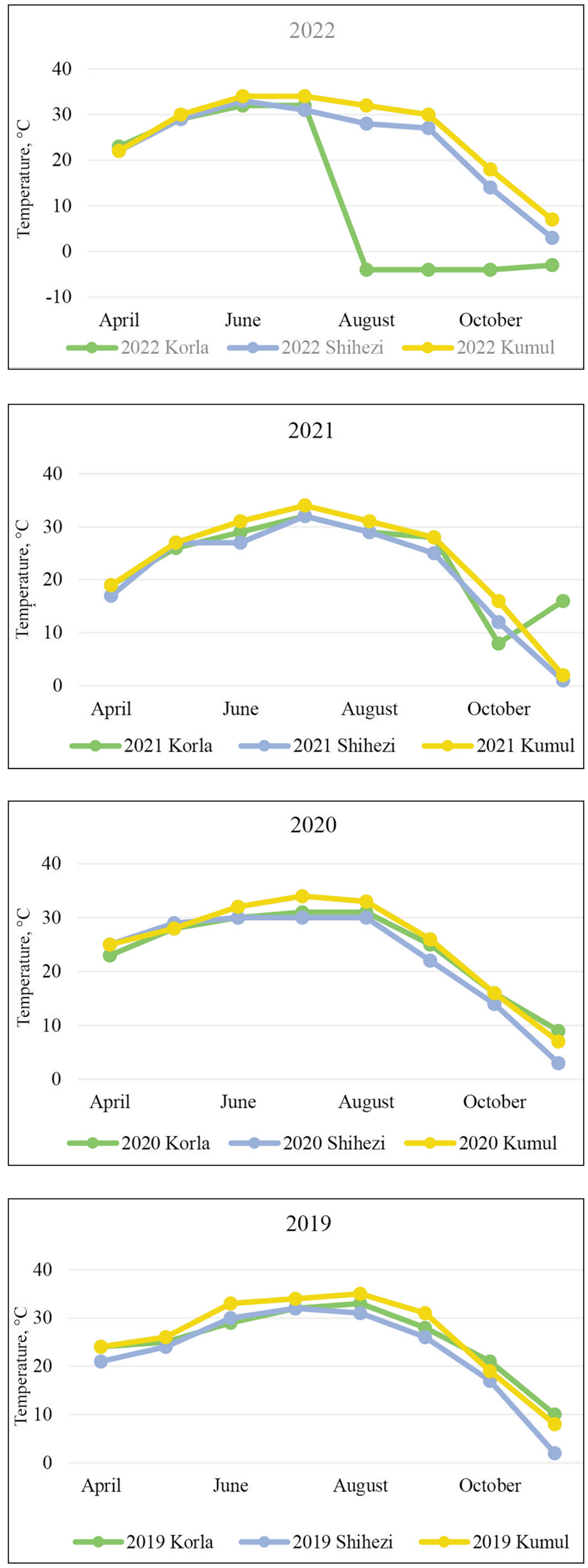


Fig. 1. Trends in cotton growing season temperatures in the three major cotton-producing regions of XJr

### Planting technique's insufficient standardization

Every cotton seed sowing season, Due to non-standard cotton planting techniques and inadequate application of scientific cultivation methods, the growth potential of cotton is limited and the quality

Table 2

| COTTON VALIDATED VARIETIES IN XJR IN 2018–2022 | | | | | |
|---|---|---|---|---|---|
| National validated varieties | | Autonomous region-validated varieties | | | |
| Validation Number | Variety Name | Validation Number | Variety Name | Validation Number | Variety Name |
| 20210013 | China Cotton 698 | 2022 No. 192 | Ginken Brown 11 | 2021 No. 32 | Santamu 6 |
| 20210011 | Ginken 1746 | 2022 No. 191 | Brown 620 | 2021 No. 31 | Huiyuan 722 |
| 20210010 | V Division 16-13 | 2022 No. 189 | Anonkhai 1 | 2021 No. 30 | Sky Cloud 2119 |
| 20210009 | V Division 16-15 | 2022 No. 188 | Jinfenghe 1 | 2021 No. 27 | Ginken 1565 |
| 20210008 | Huiyuan 162 | 2022 No. 187 | Xinto 5 | 2018 No. 45 | Ginken Miscellaneous 1062 |
| 20210007 | Medium 7700 | 2022 No. 186 | Xinto 4 | 2018 No. 44 | Y21 |
| 20210005 | New 19075 | 2022 No. 183 | Brown 928 | 2018 No. 43 | K2725 |
| 20210002 | Huiyuan 1502 | 2022 No. 182 | Brown 2305 | 2018 No. 40 | Ginken 1441 |
| 20200025 | K7 | 2022 No. 181 | Gaming 21 | 2018 No. 39 | Ginken 1161 |
| 20200023 | Bar 43541 | 2022 No. 180 | Gaming 22 | 2018 No. 38 | Ziding 6 |
| 20200022 | X19075 | 2022 No. 178 | K432 | 2018 No. 61 | MCR3915 |
| 20200020 | Ginken 1643 | 2022 No. 177 | Changfeng 2 | 2018 No. 60 | New 78 |
| 20200019 | H216 | 2022 No. 176 | H163 | 2018 No. 59 | Kono 2186 |
| 20200018 | H219 | 2022 No. 175 | Xinto 102 | 2018 No. 58 | Source Cotton New 13305 |
| 20200015 | Guoxin Cotton 26 | 2022 No. 174 | New 825 | 2018 No. 57 | Kinkai 9 |
| 20200001 | Guoxin Cotton 31 | 2022 No. 173 | CT256 | 2018 No. 55 | Sheng Cotton 2 |
| 20190023 | J8031 | 2022 No. 172 | K622 | 2018 No. 64 | H39012 |
| 20190019 | Huiyuan 1401 | 2022 No. 171 | K621 | 2018 No. 63 | Yuanlong 17 |
| 20190017 | H33-1-4 | 2022 No. 170 | Xinto 3 | 2018 No. 62 | Lutai 700Q |
| 20190016 | F015-5 | 2022 No. 169 | Anonlu 1 | 2018 No. 56 | Tower River 2 |
| 20190007 | Guoxin Cotton 25 | 2022 No. 167 | Rufunhua 861 | 2018 No. 54 | Shin Try 518 |
| 20190003 | Guoxin Cotton 18 | 2022 No. 164 | Ginken 1775 | 2018 No. 53 | Spring and Autumn S36 |
| - | - | 2021 No. 42 | Changfeng 10 | 2018 No. 52 | K418 |
| | | 2021 No. 41 | K426 | 2018 No. 51 | Ginken 1402 |
| | | 2021 No. 39 | Brown 234 | 2018 No. 50 | Z1146 |
| | | 2021 No. 38 | New 6015 | 2018 No. 48 | Ginken 1442 |
| | | 2021 No. 37 | AW05 | 2018 No. 47 | NH12026 |
| | | 2021 No. 36 | AW04 | 2018 No. 46 | T115 |

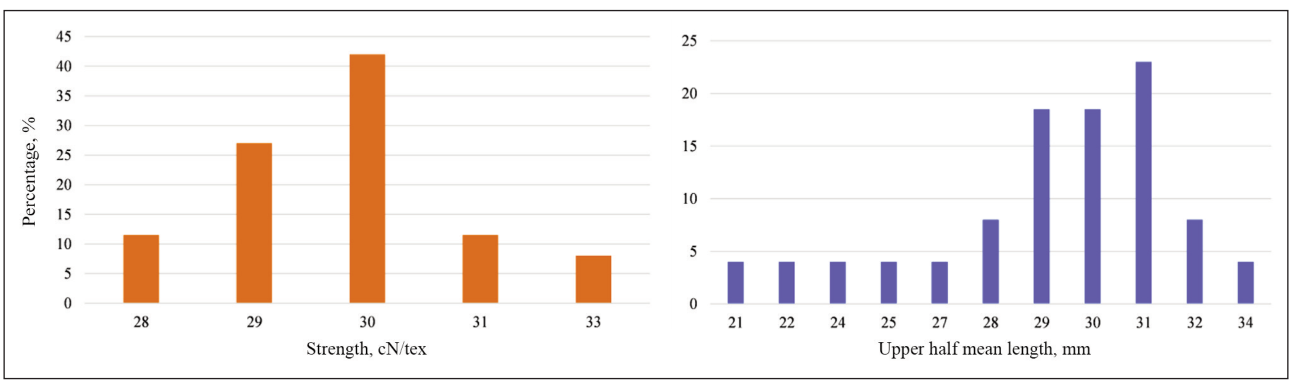


Fig. 2. The distribution of fibre quality grades among 26 cotton cultivars widely planted in the XJr Region (Source: China Seed Industry Big Data Platform)

potential of high-quality cotton is reduced. For example, in some areas, the cotton plant cultivation density is high, and row spacing is narrow [11], which leads to the narrower cotton boll-bearing part in cotton growth and the limited growth of fruiting branches. Cotton maturity in the boll area is too centralized, resulting in the late shedding of cotton bolls seriously. The same piece of cotton has different maturity conditions, plant height and boll development [12], etc. In addition, too high plant density may bring larger difficulties in field fertilization and management. It is also difficult to ensure the good growth of cotton plants, limiting the production of high-quality cotton fibres. The leaves are too dense, which is not conducive to the spraying of defoliant maturing agents and other pesticides [13, 14]. The leaves are too dense for the spraying of defoliant and other pesticides.

In recent research, it is found that in different regions of XJr, the sowing, cultivation and harvesting of cotton are not regulated in a certain way, and there may be a mixing of cotton seeds, which at the same time results in different heights of cotton plants, maturity and output fibre quality.

It can be seen, in the cultivation mode, field water and fertilizer application management, as well as other natural and man-made factors, achieving integrated control, added with the reconstruction of cotton field conditions, seeding and cultivation of cotton canopy structure will lead to “uniform distribution and structural fit” characteristics in cotton growth.

**Unreasonable distribution of sunlight exposure**

Plants cannot grow without light. Efficient light energy utilization is one of the criteria for responding to population dominance. The ability to intercept photosynthetically active radiation of plants is a major factor affecting crop yield [15–18].

Studies have shown that the photosynthetic rate of the middle leaves is the highest in all crops, and the boll yield in the middle and lower parts of the cotton is the main component of cotton yield. The plant canopy is regulated to reduce the number of upper leaves through different densities and row spacing configurations [19]. The number of leaves in the upper layer is reduced, which reduces the light interception in the upper layer and improves the light interception in the middle and lower parts of the leaves [20]. This will lead to an efficient light interception cluster to result in a higher accumulation of cotton dry matter and a consistent growth of the cotton plant [21]. The growth of cotton plants can also be maintained uniformly.

The temperature and light conditions during the growth period of cotton have a crucial impact on the formation of cotton bolls and the further development of cotton fibres. The night-time air temperature in the XJr decreases significantly. Lower night-time temperature limits the growth of cotton boll and fibre. The appropriate temperature for cotton boll growth is about 27°C ~ 30°C. Low temperature affects the metabolism of plants, which is not conducive to the accumulation of nutrients in cotton bolls, increases the weight, and reduces the rate and the amount of cellulose accumulation. The specific strength at the break of cotton fibres depends mainly on the continuous accumulation of fibre bundles. The change of cellulose accumulation characteristics directly affects the formation of specific strength at break [22, 23]. The formation of high-strength fibres should be coordinated with the accumulation of cellulose. The longer the cellulose accumulation time and the faster the accumulation rate, the greater the increase in fibre strength. The high-strength fibres can start accumulating cellulose at an early stage [24]. The study concluded that the timing of cellulose deposition has a great influence on fibre maturity and yield [25].

**Immature use of defoliation technology**

Defoliation refers to the use of specific chemicals to catalyse the leaf abscission and promote cotton boll splitting. The main effect of defoliation is to inhibit the function of growth hormone, inducing abscisic acid, ethylene and other plant hormones to exert their effects to a greater extent. The use of defoliation and ripening technology in cotton fields before mechanical harvesting is an important measure to protect the quality of cotton at the harvesting stage. Before harvesting, chemical agents are usually used for defoliation and ripening. Reasonable spraying time, application dosage and use method of defoliant ripening agent will produce good defoliant ripening effect, and can also reduce the negative impact on cotton yield and quality [26–29]. The use of chemical agents can also reduce the negative impact on cotton yield and quality.

Temperature changes after the use of defoliant ripening agents may become a major factor affecting the effectiveness of defoliant ripening. At present, the use of defoliation ripening technology is not mature and standardized. The temperature difference between daytime and night-time is large. Temperature is a key factor for the effective application of defoliation and ripening agents in cotton [30, 31]. The temperature after the application of defoliant ripening agent is required to be maintained at close to 15°C, with a maximum temperature greater than 27.5°C, and an effective cumulative temperature greater than 4.6°C. Some studies have pointed out that, in the spraying of a defoliant ripening agent, the cotton leaf shedding rate can reach 55% to 79% in 7.0 ± 1.0 days after the application.

As shown in figure 1, the early growth of cotton fibres is influenced by high temperature and sustained high temperature, so plastic film covering is generally used in cotton cultivation to keep warm. In the late stages of cotton growth, there is a wide range of temperature changes and long periods of low temperature at night. The variety of defoliant ripening agents available in the market is relatively limited. The application amount, application time and environmental conditions of defoliant ripening chemicals have a high impact on the effect [32] and also have an impact on mechanical cotton harvesting, harvesting machinery work process and harvesting effect.

**The high content of anisotropic fibres**

The cotton picking process contains profile fibres that can damage the quality of raw cotton ginning and processing. The test report from the State Fibre Inspection Bureau shows that, in mechanized cotton harvesting, there may be profile fibres such as grass, hair, plastic rope, bare mulch, not completely off-cotton leaves, broken shells, etc. mixed into the harvested cotton fibres [33]. Separating high-quality cotton fibres in subsequent fibre processing faces more difficulties, which will exacerbate the secondary damage of cotton fibres in the machine, leading to a decrease in cotton fibre length and an increase in short fibre rate, damaging the original quality of cotton fibres [34].

The harmfulness of profile fibres in cotton fibres has attracted great attention in the textile industry. In the national standards of GB 1103.1-2012 and GB 1103.2-2012 [35], regulations for various profile fibres have been added and specifically stated in the cotton picking, delivery and sale of cotton. It is also prohibited to use non-cotton pockets, coloured or non-cotton threads, and rope ties that are prone to producing anisotropic fibres. The standard strictly divides the anisotropic fibre content of wrapped cotton.

**Insufficient quality of cotton picker operations**

In our country, the cotton machine picking rate exceeded 80% in 2022 in XJr. Mechanical picking has occupied the absolute seat in cotton picking. The quality of mechanically harvested cotton has undoubtedly become a focus that needs to be sustained and highly concerned. Mechanical picking of cotton will lead to a decline in the quality of cotton fibre production, concentrated in the fibre breaking strength, and fibre neatness decline, while leading to a large increase in the rate of short fibres [36].

The rate of machine-picked cotton in XJr is all over 90%, with the highest rate reaching 99% [37, 38], far exceeding the relevant regulations in the “Cotton Picking Machine Quality” standard. Excessive picking rate will inevitably lead to an increase in impurity content in machine-harvested cottonseed and potential damage to fibres [39].

Due to the large cotton planting area in XJr, different regions use different types of harvesting machines. It is found that spindle pickers mainly introduced by Deere Company (John Deere Co.) and Case Company (JI Case Co.) are widely used. In recent years, there has also been part of the cotton area to use the bowl of Schr Ran company products (Boshiran) and also varies mechanical picking cotton fibre length shortening, breaking specific strength reduction [40, 41].

As shown in figure 3, there are differences in the impact of cotton mechanical harvesting on fibre quality indicators. Compared with hand-picked cotton, fibre length and micronaire do not significantly change, fibre strength, neatness and spinning consistency index reduce, short fibre rate increases, significantly. Between the different test points, fibre length and micronaire value in the two ways of picking are no significant difference. The fibre strength of machine-picked cotton was reduced by 3.3% to 11% than hand-picked cotton. The spinning consistency index decreases by 6.1% to 26%. The degree of neatness reduces with a small amount only 0.6% to 2.7%. The change in short fibre ratio is the largest, which is 1.0–1.9 times that of the hand-picked cotton short fibre ratio. Machine-picked cotton fibre quality factors and quality improvement pathway research 73 different varieties, machine-picked cotton fibre length and hand-picked cotton differences are very small, the micronaire and neatness are increased or decreased; fibre strength and spinning consistency index are the lowest machine-picked cotton, 63% of varieties to reach the significance of the level; machine-picked cotton short fibre rate increased significantly, is hand-picked cotton 1.6~2.3 times.

Due to the high impurity content and moisture regain of mechanically harvested cotton, cotton fibres with more impurities require more mechanical cleaning during the processing stage. More cotton fibre cleaning processes will exacerbate the damage to cotton

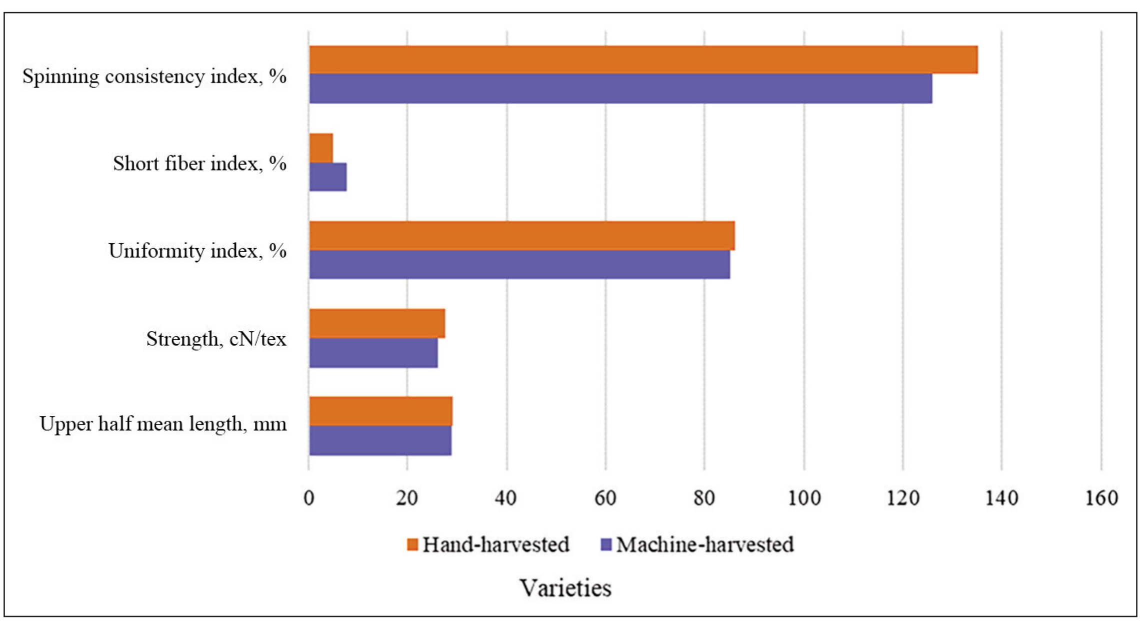


Fig. 3. Comparative indicators of differences in harvesting methods

fibres during mechanical processing, further reducing the overall quality of lint cotton [42]. Cotton processing enterprises in the processing of different grades of cotton also need to further lean processing data to ensure that the quality of cotton is effectively protected.

## RAW COTTON QUALITY OPTIMIZATION PATH

1. Machine-harvested cotton varieties require good early maturity, excellent fibre quality, fast and concentrated boll opening, high position of initial fruit nodes, more cotton in the middle and upper parts, loose and lodging resistant cotton plant type, and the ability to plant with high density. Only cotton that is sensitive to defoliation and ripening agents and has strong boll content can improve the quality of machine-harvested cotton.
2. Selection of compact, resistant, early-maturing and high-quality varieties with a high distance between the first node of the first fruiting branch and the ground (generally more than 18 cm); mechanical precision sowing by a more suitable pattern (76 cm equidistant rows, three rows in one film or six rows in one film).
3. After 20d of spraying defoliation and ripening agent, the cotton defoliation rate reaches more than 90%, and the flocculating rate reaches more than 95% when mechanical harvesting is carried out. General weather conditions require sunny days. Rainy days should not be harvested with the rate of impurity <10%, and the rate of return <12%.

## CONCLUSION

Further research is still needed in the selection and cultivation of high-quality cotton varieties and cotton cultivation. At present, research on high-quality cotton varieties focuses on high yield and disease resistance, and there may be insufficient research on cotton suitable for machine harvesting. The problem of unstable cotton quality caused by climate differences in different regions and years still needs to be studied.

From the above point of view, according to the current mechanical harvesting technology, the variety of cotton varieties suitable for mechanical harvesting in different regions is not yet diverse enough. There is still room for optimization in seeding, defoliation, ripening, and control of foreign fibres

## ACKNOWLEDGMENT

The current research was funded by the following projects:
1. "Multi-scale and multi-mechanism study of low-temperature ginning damage in cotton fibre" (National Natural Science Foundation of China, 51963020).
2. "Research on the water content state and damage mechanism of cotton fibre under wide temperature and humidity" (Xinjiang University 2022 Autonomous Region-level Innovative Training Program for Undergraduates Project, S202210755022).

## REFERENCES

[1] Department of Agricultural Mechanization Management, *National Statistical Bulletin on Agricultural Mechanization*, 2022
[2] Zhai, X.L., Yuan, R.L., Xu, G.D., *Cost-benefit analysis and international comparison of cotton production in China under the background of supply-side reform*, In: China Cotton, 2017, 44, 11, 1–7, 11
[3] Dong, H.Z., *International competitiveness analysis of China's cotton seed industry and raw cotton quality*, In: China Cotton, 2013, 40, 7, 1–5
[4] Li, Y.C., Guo, Y.Y., Wang, X.J., et al., *Analysis of climatic conditions for cotton growth in Xinjiang in 2021*, In: China Cotton, 2022, 49, 2, 1–3
[5] Wang, J.D., Li, X.Y., Liang, Y.J., et al., *Cotton seed industry report of Xinjiang cotton planting area in 2017*, In: Cotton Science, 2018, 40, 5, 5–11
[6] Meng, J.T., Wei, J.Y., Tang, S.R., et al., *Survey on fibre quality status of promoted cotton varieties in China in 2018-2019*, In: China Cotton, 2020, 47, 8, 7–9
[7] Zheng, J.Y., Gong, Z.L., Liang, Y.J., et al., *Evaluation indexes for selection and breeding of machine-picked cotton varieties in Xinjiang*, In: China Cotton, 2022, 49, 5, 1–3
[8] Li, X.Y., Wang, J.D., Zheng, J.Y., et al., *Xinjiang cotton industry development and supply-side reform,* Cotton Branch of the Chinese Society of Agriculture. Compilation of papers from the 2017 Annual Meeting and the Ninth Members' Congress of the Cotton Branch of the Chinese Society of Agriculture, In: China Cotton Magazine, 2017, 9
[9] Wang, Y.H., Shu, H.M., Chen, B.L., et al., *Null differences in fibre specific strength formation in different cotton varieties and their relationship with temperature*, In: Chinese Agricultural Science, 2008, 41, 11, 3865-3871
[10] Zheng, J.Y., Gong, Z.L., Liang, Y.J., et al., *Evaluation indexes for selection and breeding of machine-picked cotton varieties in Xinjiang*, In: China Cotton, 2022, 49, 5, 1–3
[11] Li, L., Dong, H.L., Ma, Y.Z., et al., *Effects of plant-row spacing configuration on growth and development, yield and quality of machine-picked cotton*, In: Xinjiang Agricultural Science, 2020, 57, 4, 713–721
[12] Li, J.F., Ling, F.B., Cheng, H.D., et al., *Effects of plant-row spacing configuration on agronomic traits and yield in cotton machine picking mode*, In: Xinjiang Agricultural Science, 2016, 53, 8, 1390–1396
[13] Tian, J.S., Zhang, X.Y., Wang, W.M., et al., *Effects of cotton defoliant on fibre quality and determination of application time*, In: Crop Journal, 2020, 46, 9, 1388–1397
[14] Yan, W., Li, F.J., Xu, D.Y., et al., *Effects of row spacing and nitrogen fertilizer or meperidine chemical control on canopy structure, temperature and relative humidity in cotton*, In: Crop Journal, 2021, 47, 9, 1654–1665
[15] Wang, Z.K., Wu, P.T., Zhao, X.N., et al., *Progress of research on the mechanism of light energy interception and utilization in crop intercropping groups*, In: Journal of Natural Resources, 2015, 30, 06, 1057–1066

[16] Dong, H.Z., Zhang, Y.J., Zhang, D.M., et al., *A new cotton population structure based on centralized harvesting*, In: Chinese Agricultural Science, 2018, 51, 24, 4615–4624
[17] Zhang, W., Lu, T., Zhao, F.Q., et al., *Effects of defoliant on cotton yield under different row spacing configurations*, In: China Cotton, 2019, 46, 1, 34–37
[18] Zhang, W., Lu, T., Liu, Q.Y., et al., *Effects of defoliants on cotton integrated traits under different row spacing configurations*, In: Modern Pesticides, 2020, 19, 2, 52–56
[19] Zhang, W., Liu, Q.Y., Zheng, Q.T., et al., *Effects of different row spacing configurations on growth and development and photosynthetic characteristics of machine-picked cotton*, In: Arid Zone Agricultural Research, 2022, 40, 5, 155–164
[20] Leuchner, M., Hertel, C., Menzel, A., *Spatial variability of photosynthetically active radiation in European beech and Norway spruce*, In: Agricultural and Forest Meteorology, 2011, 151, 1226–1232
[21] Li, J.F., Hu, Y.F., Li, X.Q., et al., *Effects of applying different types of nitrogen fertilizers on cotton growth and development and yield*, In: China Cotton, 2017, 44, 4, 24–26
[22] Dai, S., Cunningham, P., Marshall, S., et al., *Influence of fibre architecture on the tensile, compressive and flexural behaviour of 3D woven composites,* In: Composites Part A, 2015, 69195–69207
[23] Wang, W.M., Tian, J.S., Zang, X.Y., et al., *Effects of defoliant spraying on cotton on sucrose metabolism in cotton bolls and its relationship with fibre specific strength*, In: Xinjiang Agricultural Science, 2016, 53, 9, 1580-1586
[24] Han, Z., Hu, Y., Tian, Q., et al., *Genomic signatures and candidate genes of lint yield and fibre quality improvement in Upland cotton in Xinjiang*, In: Plant Biotechnol., 2020,18, 10, 2002–2014
[25] Noureddine, A., Eric, H., Luis, C., *Changes in sugar composition and cellulose content during the secondary cell wall biogenesis in cotton fibres*, In: Cellulose, 2010, 17, 153–160
[26] Zang, W., Lu, T., Zhao, F., et al., *Effects of defoliant on cotton yield under different row spacing configurations*, In: China Cotton, 2019, 46, 1, 34–37
[27] Zhang, W., Lu, T., Liu, Q.Y., et al., *Effects of defoliants on cotton integrated traits under different row spacing configurations*, In: Modern Pesticides, 2020, 19, 2, 52–56
[28] Wang, W.M., Tian, J.S., Zhang, X.Y., et al., *Effects of defoliant spraying on cotton on sucrose metabolism in cotton bolls and its relationship with fibre specific strength*, In: Xinjiang Agricultural Science, 2016, 53, 9, 1580–1586
[29] Tian, J.S., Zhang, X.Y., Wang, W.M., et al., *Effects of cotton defoliant on fibre quality and determination of application time*, In: Crop Journal, 2020, 46, 9, 1388–1397
[30] Li, Y.C., Guo, Y.Y., Wang, X.J., et al., *Analysis of the climate conditions for cotton growth in Xinjiang in 2021*, In: China Cotton, 2022, 49, 2, 1–3
[31] Wang, X.J., Li, Y.C., Fu, W.G., et al., *Analysis of meteorological conditions for cotton growth in Xinjiang in 2020*, In: China Cotton, 2021, 48, 3, 42–44
[32] Gao, X.K., Hu, J., *Machine-picked cotton: a realistic choice to reduce cotton production costs--a study on the current situation and countermeasures of machine-picked cotton promotion in Xinjiang Corps*, In: Research World, 2006, 6, 28–30, 33
[33] Feng, Z.X., Cao, Y., Yan, Y.P., et al., *Effects of single and double row configurations on machine-picked cotton yield and impurity rate under different density conditions*, In: Modern Agricultural Science and Technology, 2017, 709, 23, 13, 15
[34] Xu, H., Cao, J.Q., Ye, W., et al., *Effect of sawtooth lint cleaning on machine-picked cotton performance*, In: Journal of Textile Research, 2014, 35, 1, 35–39
[35] GB 1103.1-2012, *Cotton – Part 1: Saw ginned upland cotton*, GB 1103.2-2012, *Cotton – Part 2: Roller ginned upland cotton,* National Standard Information Public Service Platform
[36] Tian, J.S., Wang, W.M., Wang, C., et al., *Effects of mechanical harvesting methods on cotton quality in Xinjiang*, In: Journal of Textile Research, 2016, 37, 07, 13–17, 33
[37] Wei, X., Zhang, S.L., Ren, Y., et al., *Effects of different planting densities on net picking rate and yield of machine-picked cotton*, In: Xinjiang Agricultural Reclamation Science and Technology, 2014, 37, 2, 8–9
[38] Wang, Y., Ling, Y., Li, L.H., *Investigation and analysis of cotton picking net rate,* In: Xinjiang Agricultural Reclamation Science and Technology, 2015, 38, 11, 12–14
[39] Li, M.C., Wang, W., *Measures to improve the quality of cotton in Xinjiang*, In: Xinjiang Agricultural Reclamation Science and Technology, 2000, 2, 6–8
[40] Xu, H., Xia, X., *Comparison of the performance of machine-picked cotton and hand-picked cotton*, In: Journal of Textile Research, 2009, 30, 9, 5–10
[41] Song, M., *Analysis of machine picking characteristics of cotton main cultivars in Xinjiang*, Xinjiang: Xinjiang Agricultural University, 2015
[42] Zang, Y.B., Tian, S.R., Zhang, H.L., et al., *Research on the promotion of machine-picked cotton in Xinjiang cotton area*, In: China Cotton Processing, 2015, 2, 18–19

**Authors:**

JUNYANG WANG, LIMIN ZHANG, JINCHAN ZHANG, WANXIN WANG, HONG XU

College of Textile and Clothing, Xinjiang University, Urumqi, Xinjiang, 830017, China

**Corresponding author:**

LIMIN ZHANG
e-mail: zlm629@126.com