# Analysis of factors affecting the impurity rate of mechanically-harvested maize grain in China

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**Abstract:** The grain impurity rate is an important index for assessing the quality of mechanical maize harvesting. Therefore, it is of great significance to clarify the current situation of maize impurity rate and study the factors that affect the impurity rate in order to promote the development of mechanical maize harvesting technology. From 2012 to 2019, a total of 2504 maize impurity rate measurements were obtained. The results showed that the average impurity rate at maize harvest was 1.18% in China, in which the Huang-Huai-Hai summer maize area was 1.68%, which was significantly higher than the 0.65% in the Northwest spring maize area and 0.77% in the North China spring maize area. There was a significant positive correlation between the impurity rate and the moisture content of the maize harvest. The average moisture content of maize at harvest in Huang-Huai-Hai summer maize area was the highest at 27.55%, which was the main reason for the high impurity rate in this area. When harvesting different varieties with the same moisture content, there were significant differences in the impurity rate between different varieties. The cob hardness of the variety may also affect the impurity rate of maize. Different harvesters and weather conditions during harvesting are also important factors affecting the impurity rate. Therefore, by breeding fast dehydrated varieties and harvesting maize in time, the impurity rate of maize during mechanical harvesting can be effectively reduced.

**Keywords:** mechanically-harvested maize grain, impurity rate, factors, analysis

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## 1 Introduction

Maize (*Zea mays* L.), as the main force in increasing grain production in China, has grown to more than 500 million mu, making it the largest crop with the largest total yield. The mechanical grain harvesting technology of maize began in North America in the 1950s and has been widely promoted since the 1970s[1,2]. Introduced advanced harvesting machinery and varieties from Europe, America and other countries, and began to apply maize mechanical grain harvesting technology. The impurity rate of maize harvested in the United States is between 0% and 7.3%, with an average value of 0.62%, and the inter-field variation is small. China first introduced advanced harvesting machinery and varieties from Europe, America and other countries in Xinjiang Corps and Heilongjiang Agricultural Reclamation in the 1990s, and began to apply maize mechanical harvesting technology. They led the Xinjiang production and construction corps to study the influence of maize variety, grain moisture content, and other factors on the quality of mechanical maize harvesting in 2011[3]. Early reports showed that the impurity rate of mechanically harvested maize grains in China was between 0% and 18.01%, with an average value of 1.27%[4]. Previous studies have shown that the quality of harvested maize is not only affected by the grain moisture content[5,6], Grain moisture content has a great impact on maize harvesting, drying, etc.

Excessive moisture content often causes maize growers and operators to suffer economic losses and reduce economic benefits. Maize grain moisture content during harvest is mainly Controlled by the dehydration rate of grains before and after physiological maturity, this trait is heritable, and there are significant differences between varieties, and the dehydration rate between varieties is related to many agronomic traits such as bracts, cobs, and grain characteristics but also by the harvester type and operation, cultivation measures, weather conditions at harvest time, and harvest time[7,8].

Between 2012 and 2019, The Crops and Physiology Innovation Team of the Chinese Academy of Agricultural Sciences carried out research and demonstration of maize mechanical grain harvesting technology in the Northwest and North China spring maize regions and the Huang-Huai-Hai summer maize region, obtained 2504 sets of mechanical grain impurity rate data. When investigating the impurity rate, we found that the cob and leaf residue of the main components of the maize impurity rate, so does the cob hardness also affect the impurity rate? Different varieties of cob hardness are different, and the impurity rate of the same variety

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is different when harvested by different machines, we designed a series of tests based on these problems to comprehensively analyze the factors affecting the impurity rate.

## 2 Materials and methods

### 2.1 Study area

This study was conducted in experimental fields at 97 sites in Northwestern China (NW), North China (NC) and Huang-Huai-Hai (HH) during 2012–2019 (Figure 1). As the main maize producing areas of China, NW, NC and HH all have a typical continental climate, i.e., hot summers with abundant solar radiation, large daily temperature range, and cold and windy winters (Figure 2).

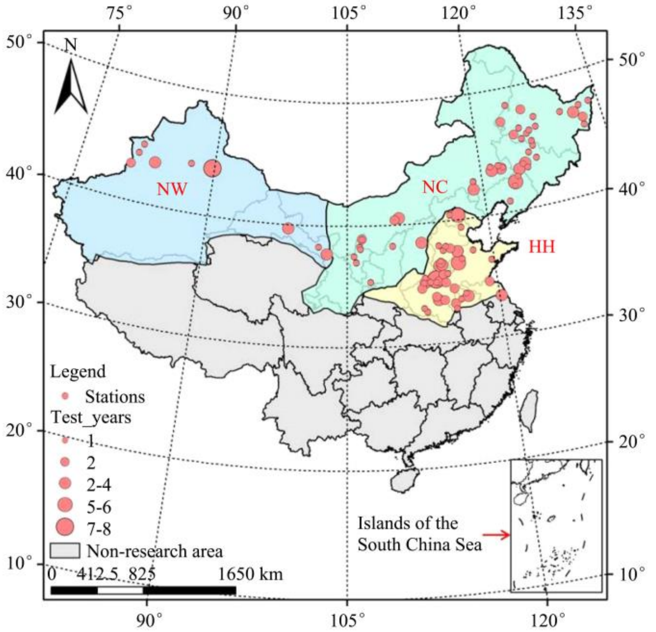



Figure 1 Distribution of experimental fields at 97 sites in the study area

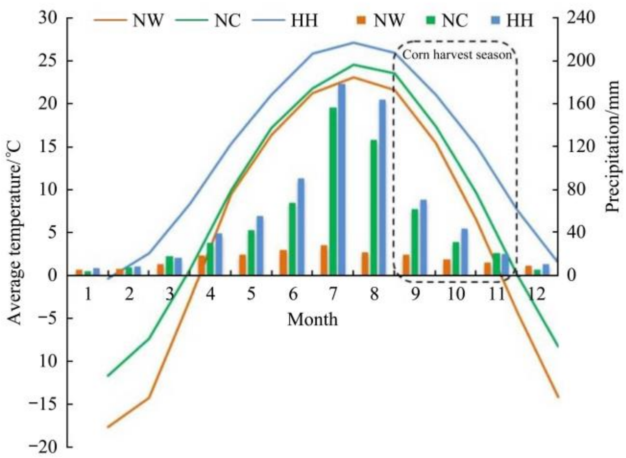



Figure 2 Monthly average temperature and precipitation in NW, NC and HH from 1961-2015

### 2.1 Experimental design

2.1.1 Impurity rate investigation test

The experimental design was a fully randomized complete block. From 2012 to 2019, a total of 753 hybrids of maize were conducted and the size of the plot (an area of 667 $m^2$). At least four protection lines were set around the experimental area. Sowing density and fertilizer application were the same as those used locally, which were 105 000 plants/$hm^2$ in NW and 67 500 plants/$hm^2$ in NC and HH. Irrigation was adopted when necessary to ensure sufficient water for maize growth.

2.1.1 Maize cob hardness test

In 2017, a total of 28 maize hybrids were planted over large areas at the comprehensive experimental station of the Institute of Crop Science, Chinese Academy of Agricultural Sciences, located in Henan Province (35°10′N, 113°47′E) in Table 1. The number of planting rows for each hybrid was more than 10, the planting area was more than 600 $m^2$, and the planting density was 6.75× $10^4$ plants/$hm^2$. Mechanical grain harvesting was carried out in the field on 6th October, 16th October, 27th October, 10th November, and 25th November. The harvester was a Lovol Gushen GE 50 with a cutting width of 4 rows, and the same machine and operator were used for five harvests. The running speed, rotating speed, height of the harvester, size of the screen hole, and other settings of the harvester were the same for the five harvests. The length of each harvest was more than 20 m. The impurity rate and other relevant quality indexes were tested after harvesting.

**Table 1 Maize hybrids used for the cob hardness analysis**

| Experimental site | Number of hybrids | Maize hybrids |
|---|---|---|
| Xinxiang | 28 | Liaodan 585, Liaodan 586, Liaodan 575, MC670, Zeyu 501, Zeyu 8911, Jidan 66, Dongdan 913, Yufeng 303, Zhongkeyu 505, Lianchuang 808, Lianchuang 825, Jintong 152, Nonghua 5, Nonghua 816, Hengyu 898, Dika 517, Dika 653, Xindan 58, Xindan 65, Xindan 68, Shandan 636, Shandan 650, Yuyu 30, Lidan 295, LA505, Beidou 309, Yudan 9953 |

2.1.3 Different mechanical harvesters test

In 2019, a total of 3 sets of comparative experiments were arranged during the maize harvest season, of which 1-2 groups were conducted in Tieling City, Liaoning Province, and the 3 groups were conducted in Suzhou City, Anhui Province. All types of grain harvesters were used to harvest the same variety of maize in the same field. After the maize is harvested, test the moisture content and impurity rate of the grain (Table 2).

**Table 2 Comparison of the average impurity rates of maize obtained with different types of harvesting machines**

| Number of groups | Type of combine machine | Number of Harvesting lines | Variety | Site | Maize type |
|---|---|---|---|---|---|
| 1 | Case 4088 | 6 | Liaodan 575 | Tieling, Liaoning | Spring maize |
| | John Deere C110 | 6 | | | |
| 2 | Case 4088 | 6 | Liaodan 585 | Tieling, Liaoning | Spring maize |
| | John Deere C110 | 6 | | | |
| 3 | Haofeng 5 | 4 | Zhengdan 958 | Suzhou, Anhui | Summer maize |
| | World 7 | 4 | | | |
| | World 5 | 4 | | | |
| | Guwang 8 | 4 | | | |
| | Gushen 120 | 4 | | | |

Note: Case 4088: CS-4088, John Deere C110: JD-C110, Haofeng 5: HF-5, World 7/World 5: WD-7/5, Guwang: ZL-8, Gushen GK120: GK120.

### 2.2 Main investigation, test indexes, and methods

2.2.1 Grain moisture content and impurity rate

At each test site, upon harvesting, about 2 kg of maize samples (i.e., both grains and non-grains) were randomly taken from the grain tank of the combine harvester. What needs to be noted is that in order to prevent the different speed of the harvester from starting or stopping, resulting in uneven samples, the samples were usually obtained during the period when the harvester is walking at a constant speed. First, the grain moisture content was immediately measured using a PM-8188 grain moisture meter (Kett Electric Laboratory, Tokyo, Japan) with five repetitions. Second, samples were divided into a grain fraction and a non-grain fraction by manual sorting, and each fraction was weighed separately. Three repetitions were performed for each variety, and the stated impurity rate is the average of the three repetitions. Finally, using these two weights, the impurity rate was calculated as follows:

$$\text{Impurity rate (\%)} = \left(\frac{KW2}{KW1+KW2}\right)\times 100 \tag{1}$$

where, $KW1$ is the weight of the grain fraction and $KW2$ is the weight of the non-grain fraction.

2.2.2 Cob penetration strength

Before the mechanical harvesting of maize, five maize ears were randomly selected from the field, and the characteristic parameters of maize cobs were determined with a stalk strength tester (Zhejiang Top Instrument Co., Ltd, Hangzhou, China). A probe with a diameter of 1 mm and a length of 1.5 cm was inserted half of the way to the center of the cob at a steady speed perpendicular to the cob length axis, and the maximum value of the outer wall of the cob was recorded. Each cob was measured four times[9,10].

### 2.3 Data analysis

The test data were processed and analyzed using Microsoft Excel 2010 and SPSS 22.0 (IBM, Armonk, NY, USA) software, and the data were mapped using the Oring 2018 software and ArcMap.

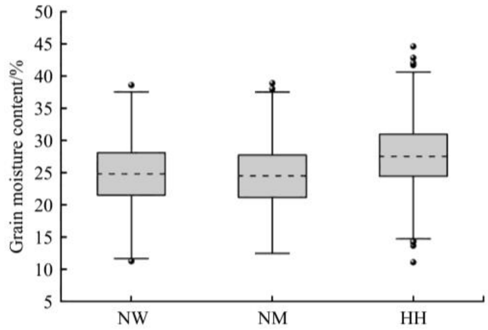
## 3 Results

### 3.1 Impurity rate of mechanically harvested maize grains

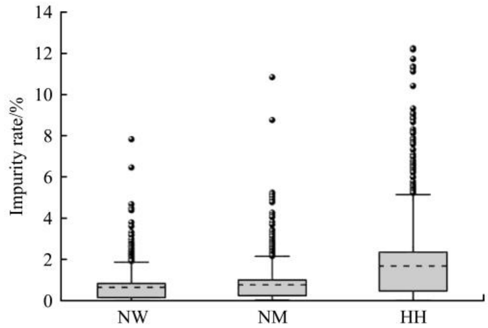
The data analysis results for the 2504 measurements of mechanically harvested grain samples obtained in three major maize-producing regions from 2012 to 2019 are shown in Figure 3 and Table 3. The mean impurity rate is 1.18%, among different regions, the grain impurity rate was highest in the Huang-Huai-Hai summer maize area, with an average value of 1.68%. The grain impurity rate was second-highest in the North China spring maize region, with an average value of 0.77%, while the lowest impurity rate was observed in Northwest China irrigated maize region, with an average value of 0.65%. The maximum impurity rate was 12.25%, the minimum was 0%, and the coefficient of variation (CV) was 129.82%, indicating that the harvest quality was significantly different between fields and hybrids.

**Table 3 Statistics of the impurity rate of harvested grains in different regions**

| Item | Regions | Number | Max/% | Min/% | Average/% | Range/% | CV/% |
|---|---|---|---|---|---|---|---|
| MC | NW | 728 | 38.60 | 11.30 | 24.84±4.82 | 27.30 | 19.42 |
| | NM | 704 | 38.90 | 12.50 | 24.54±4.72 | 26.40 | 19.23 |
| | HH | 1072 | 44.60 | 11.13 | 27.55±5.00 | 33.47 | 18.17 |
| | Total | 2504 | 44.60 | 11.13 | 25.92±11.13 | 33.47 | 19.58 |
| IR | NW | 728 | 7.83 | 0.00 | 0.65±0.79 | 7.83 | 122.06 |
| | NM | 704 | 10.85 | 0.02 | 0.77±0.94 | 10.83 | 121.66 |
| | HH | 1072 | 12.25 | 0.00 | 1.68±1.85 | 12.25 | 110.15 |
| | Total | 2504 | 12.25 | 0.00 | 1.18±1.53 | 12.25 | 129.82 |




a. Grain moisture content of maize during harvest in the study areas



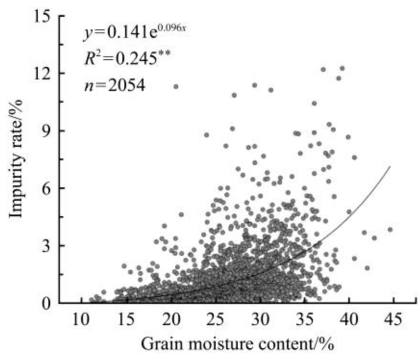

b. Impurity rate of maize during harvest in the study areas

Note: Abbreviated symbols in the figure are shown in Figure 1.

Figure 3 Comparison of grain moisture content and impurity rate of maize during harvest in different regions

### 3.2 Relationship between impurity rate and grain moisture content

Plots of grain moisture content against the impurity rate for the 2 504 measurements are shown in Figure 4. As can be seen from Figure 4, there is a very significant positive correlation between impurity rate and grain moisture content. These two parameters can be fitted by the exponential equation $y=0.141e^{0.096x}$ ($R^2=0.245^{**}$). Comparing the changes of impurity rate in the two periods of 2012-2015 (B) and 2016-1019 (A), the results showed that the impurity rate was greater than 3%, the impurity rate was A less than B 1.03%, 4.57%, 18.81% in NW, NC, HH respectively, and the impurity rate is less than 1%, increase by 19.02%, 26.29% in NC, HH. At the same time, the ratio of grain moisture content greater than 30%, A compared with B, decreased by 1.03%, 4.57%, 18.81%, the grain moisture content is less than 20.00%, increase by 1.28%, 6.39%, 7.82% in NW, NC, HH respectively. Therefore, the main reason for the lower impurity rate of maize in 2016-2019 than in 2012-2015 is the drop in grain moisture content, which has many factors, such as the certification and promotion of varieties suitable for mechanical grain harvesting.




Note: $y$ is the impurity rate; $x$ is the grain moisture content; ** represents significance at the $p$<0.01 level.

Figure 4 Relationship between grain moisture content and grain impurity rate in different regions

**Table 4 Distribution of impurity rate and moisture content in different years**

| Years | Regions | Impurity rate | | Grain moisture content | |
|---|---|---|---|---|---|
| | | IR≥3% | IR≤1% | M≤20% | M≥30% |
| 2016-2019 (A) | NW | 1.28% | 75.85% | 18.59% | 9.83% |
| | NC | 1.25% | 83.75% | 16.75% | 6.75% |
| | HH | 13.49% | 55.48% | 8.44% | 28.40% |
| 2012-2015 (B) | NW | 2.31% | 85.38% | 17.31% | 10.00% |
| | NC | 5.82% | 64.73% | 9.82% | 10.91% |
| | HH | 32.30% | 29.19% | 0.62% | 44.10% |
| A-B | NW | −1.03% | −9.53% | 1.28% | −0.17% |
| | NC | −4.57% | 19.02% | 6.93% | -4.16% |
| | HH | −18.81% | 26.29% | 7.82% | −15.70% |

### 3.3 Differences in impurity rates among different maize hybrids

The 2504 measurement values were divided into the following five groups according to the same harvester and moisture content. The harvest moisture content ranges from 26% to 34%. It can be seen from Table 5 that when the moisture content is the same, there are significant differences between different hybrids. These results indicate that genetic factors have an impact on the impurity rate.

### 3.4 Correlation between maize cob characteristics and impurity rate

The correlation between the grain impurity rate and various grain and cob characteristics was analyzed using the fractional harvest test. The results are shown in Table 6. As shown in the table, there was found to be a weak negative correlation between cob penetration strength and impurity rate, however, this correlation was not statistically significant.

**Table 5 Grain impurity rate of different maize hybrids under the same moisture content**

| Number of groups | Year | Site | Hybrid | Harvest grain moisture/% | Impurity rate/% | Harvester |
|---|---|---|---|---|---|---|
| 1 | 2013 | Xinxiang, Henan | Dedan121 | 31.0 | $2.95^{c}$ | Lovo GE60 |
| | | | Dedan5 | | $5.13^{a}$ | |
| | | | Huayu15 | | $2.94^{c}$ | |
| | | | Zhongdan909 | | $1.80^{d}$ | |
| | | | Zhendan958 | | $3.99^{b}$ | |
| 2 | 2014 | Luohe, Henan | Dika 517 | 33.4 | $1.31^{d}$ | Lovol GE60 |
| | | | Longping206 | | $5.12^{a}$ | |
| | | | Ningyu614 | | $1.92^{d}$ | |
| | | | Xianyu335 | | $3.32^{c}$ | |
| | | | Zhengdan958 | | $4.95^{ab}$ | |
| 3 | 2017 | Chenan, Hebei | Chengyu88 | 30.6 | $1.81^{c}$ | Lovol GE60 |
| | | | Denghai605 | | $3.26^{a}$ | |
| | | | Hengyu898 | | $1.38^{c}$ | |
| | | | Xiangyu998 | | $2.50^{b}$ | |
| 4 | 2018 | Renping, Shangdong | Dika667 | 29.1 | $0.87^{bc}$ | GWTB 60 |
| | | | Denghai618 | | $1.11^{b}$ | |
| | | | Zeyu8911 | | $2.25^{a}$ | |
| 5 | 2019 | Chifeng, Inner Mongolia | Deli666 | 26.7 | $2.54^{a}$ | Dongfeng 2000 |
| | | | Jidan63 | | $0.65^{c}$ | |
| | | | Nonghua106 | | $1.25^{b}$ | |

Note: Values followed by different letters are significantly different at $p$<0.05.

**Table 6 Results of correlation analysis between grain impurity rate and grain moisture content, cob moisture content, and cob penetration strength**

| Harvest date (month-day) | Number of samples | Grain moisture content/% | Cob moisture content/% | Cob penetration strength/N |
|---|---|---|---|---|
| 10-6 | 28 | $0.157^{ns}$ | $0.064^{ns}$ | $-0.137^{ns}$ |
| 10-16 | 28 | $0.132^{ns}$ | $0.553^{**}$ | $-0.190^{ns}$ |
| 10-27 | 28 | $0.352^{ns}$ | $0.127^{*}$ | $-0.142^{ns}$ |
| 11-10 | 28 | $0.403^{*}$ | $0.411^{*}$ | $-0.148^{ns}$ |
| 11-25 | 28 | $0.392^{*}$ | $0.406^{*}$ | $-0.143^{ns}$ |

Note: * and ** represent significant difference at the $p$<0.05 and $p$<0.01 levels, respectively; ns represents no significant difference.

### 3.5 Difference in impurity rate with different mechanical harvesters

In 2019, grain quality was assessed for grain harvested with different harvesters in Tieling County, Liaoning Province and Suzhou District, Anhui Province. The results are shown in Table 7. As shown in the table, for Tieling County, the impurity rates for the maize hybrids harvested with a Case harvester (CS-4088) were lower than those of the same hybrids harvested using a John Deere harvester (JD-C110), however, this difference was not statistically significant. However, for Suzhou District, significant differences in impurity rate were observed for different types of harvester. The lowest impurity rate was observed for the Haofeng harvester (HF-5), followed by the Guwang (ZL-8) and Gushen (GK120) harvesters, while the highest impurity rate was observed for the World harvester (WD-5). In Suzhou District, only the HF-5 and ZL-8 harvesters met the requirements for the national standard for the impurity rate (≤3%).

**Table 7 Comparison of the average impurity rates of maize obtained with different types of harvesting machines**

| Years | Places | Cultivar | Harvester type | MC/% | IR/% |
|---|---|---|---|---|---|
| 2019 | Tieling, Liaoning | Liaodan 575 | CS-4088 | 18.2 | 0.39[a] |
| | | | JD-C110 | | 0.75[a] |
| | | Liaodan 585 | CS-4088 | 23.5 | 0.63[a] |
| | | | JD-C110 | | 1.04[a] |
| 2019 | Suzhou, Anhui | Zhengdan 958 | HF-5 | 29.4 | 1.52[c] |
| | | | WD-7 | | 8.18[b] |
| | | | WD-5 | | 11.37[a] |
| | | | ZL-8 | | 2.72[c] |
| | | | GK120 | | 3.46[c] |

Note: Values followed by different letters are significantly different at $p$<0.05.

## 4 Discussion

### 4.1 High impurity rate of mechanically harvested grain in some plots

The analysis of the 2504 measurements of mechanically harvested grains from 2012 to 2019 showed that the average impurity rate was 1.18%. However, there was a large difference in impurity rate between different plots, with values ranging from 0% to 12.25% and a coefficient of variation of 129.82%. Data published annually by the United States Department of Agriculture show that in the United States, harvested maize generally has an impurity rate of 0%–7.30%, with an average of 0.62%. The fact that lower impurity rates are observed for U.S. maize compared to those found in the present study suggests that there is a need to decrease the impurity rate in mechanically harvested maize in the future in China.

### 4.2 Main factors affecting impurity rate

Grain moisture content is a key factor influencing the quality, safety, and economic benefit of maize harvesting[11]. Previous studies have found the influence of grain moisture content, yield level, planting density and other factors on the mechanical harvest quality of maize. During the mechanical harvesting process, the grain moisture content and the impurity rate have a significant correlation, and it is recommended to select appropriate early maturity and mature periods Varieties with low grain moisture content and fast dehydration rate can effectively reduce the impurity rate, which is consistent with the results of this study. However, previous studies did not fully analyze the influencing factors of impurity rate, such as whether there are differences in impurity rates between different varieties, and whether there are differences between different machines[3,4]. For this reason, this study analyzes the above factors more comprehensively on the basis of previous studies. In this study, the relationship between grain moisture content and grain impurity rate was investigated in three major maize-producing regions of China, and it was found that these two parameters can be fitted by an exponential equation. Additionally, this study observed a decrease in both grain moisture content and impurity rate in recent years. The impurity rate in the summer maize sowing region of Huang-Huai-Hai was significantly higher than those in Northwest China and North China spring maize regions, which may be related to the higher overall grain moisture content at harvest time in the Huang-Huai-Hai region. In Huang-Huai-Hai summer maize region, summer maize from sowing to harvesting time is shorter, the heat is not enough, the late harvest when some maize hybrids are not mature, for example, on June 13, sowing seeds, in early October or began to harvest, less than four months. Especially in the northern part of the Huang-Huai-Hai region, there is a shortage of heat resources, which leads to late maturity, coupled with late planting of winter wheat, and long grain dehydration time[12]. The average grain moisture content in the Huang-Huai-Hai region was 27.55%, while those in the Northwest and North China regions were 24.84% and 24.54%, respectively. Moreover, the rainfall and temperature in Huang-Huai-Hai region were significantly higher than those in other maize-producing areas during the maize harvest season. Temperature affects crop hardness, precipitation affects adhesion between crops, both of which comprehensively affect crop cleaning quality, and finally affect the hybrid ratio[13].

### 4.3 Other important factors affecting impurity rate

To study three maize hybrids from the United States, Germany, and China, respectively, and found that there were significant differences in the relationship between grain moisture content and mechanical harvest quality indexes (e.g., crushing rate) among maize hybrids from different sources[3]. Additionally, the cob moisture content and cob mechanical strength were important factors affecting the breakage rate of maize grains[14], however, the relationship between these two parameters and the impurity rate is not yet known. The results of the present study show that the impurity rate is mainly affected by the grain moisture content and cob moisture content. Additionally, this study found that there is a weak negative correlation between the impurity rate and the cob hardness, which suggests that soft cob hybrids are associated with higher impurity rates. According to the results for five groups according to the same harvester and moisture content, the impurity rate of variety Zhengdan 958 (ZD958) is significantly higher than that of other hybrids, such as Xianyu 335 (XY335), indicating that there is a genetic component to differences in impurity rate. Although the hybrids ZD958 and XY335 had similar growth periods, in ZD958, the green persistence is longer, the cob shaft length and leaf moisture content are significantly higher, and the cob hardness is lower compared to XY335, which may be the main reason for the higher impurity rate of this variety[15,16]. In terms of variety, the number of bracts, straw diameter, ear size, etc., all directly affect the threshing effect and hybrid rate. There is a great difference in grain dehydration rate between different types of maize grains before and after physiological maturation, and this difference is controlled by genetic genes[17], the grain moisture content and the dehydration rate of maize at different maturity stages were significantly different[18].

Harvester type and operation also appear to be important factors affecting the impurity rate of maize. Different types of harvesters have different crushing rates due to different mechanical parameters such as drum speed, concave plate clearance, size of vibrating screen, and wind force of the cleaning fan[19-22]. In 1997, International Harvester introduced the axial-flow combine harvester technology, which significantly improved the quality and efficiency of mechanical harvesting[23,24]. Additionally, the feeding amount in the harvest, the uniformity of the feeding, and the method of maize ear entering also affect the quality of mechanical harvesting[25]. However, eight different harvesters of the same model (Foton GE60) were used for the harvest comparison test in Linying, Henan Province, in 2015, in which the harvested maize variety was Zhongzhong 8 (ZZ8), and the moisture content at harvest was 25.00%. The test result showed that the impurity rate varied from 0.23% to 2.07%, reaching a significant level ($p$<0.05)[7]. The reason for this may be related to the different settings of threshing drum speed, screen clearance, and fan speed between different machines, as well as differences in personnel operation. In present studies, it was observed that when the grain moisture content was high, impurities such as stem, leaf, and cob fragments were not easily blown away by the harvester fan due to their high moisture content and that in the separation and sorting process broken leaves would be included in the grain fraction and sent to the grain bin, leading to a higher impurity rate. Therefore, it is clear that differences in mechanical operation are an important factor causing a high impurity rate of maize. It should be noted that at present, this study on the impact of different harvesting machines on maize impurity rate is still not comprehensive enough. In the future, we will comprehensively develop the impact of different harvesters such as John Deere, Case, Gushen, etc. on the maize impurity rate. What we need to do next is different settings and tests have not been carried out for key operating parameters, including the fan speed of the cleaning system, the type and opening of the cleaning screen, the speed of the threshing system, threshing clearance, and so on.

## 5 Conclusions

At present, the average impurity rate of maize harvested by machinery is 1.18%, among them, the Huang-Huai-Hai summer maize area is 1.68%, the northern spring maize area is 0.77%, and the northwest irrigated maize area is 0.65%. The grain moisture content at harvest is the main factor affecting the impurity rate, except for the variety, climatic conditions, and harvesting machinery and equipment that have significant impacts on the impurity rate.

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