# OPTIMIZATION AND EXPERIMENT OF CONVEYING TURNOVER DEVICE BASED ON PEANUT PLANT CHARACTERISTIC PARAMETERS

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# 基于花生植株特性参数的输送翻转装置优化与试验

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*DOI: https://doi.org/10.35633/inmateh-75-57*

***Keywords***: *Peanut parameters; Peanut flip；Experiment；Simulation*

## ABSTRACT

*Aiming at the problem that there are few studies on the turnover device in the current peanut laying operation equipment and lack of simulation parameters, this study measured the characteristic parameters of upright peanut plants and tested the feasibility of conveying the turnover device to flip the vine. By studying the mechanical properties of peanut plants, the suitable clamping height range of plants was determined. By studying the size, mass parameters and distribution of peanut plants, the possibility of plant flipping and falling was analyzed, and the main structure and working principle of the conveying flipping device were determined. Based on the RECURDYN-EDEM coupling, the joint simulation of the conveying and overturning device was carried out to complete the dynamic analysis of the plant conveying and overturning process, and the simulation parameters were further optimized. The test results show that the device can achieve 95.1 % plant turnover completion and improve the quality of field drying, which can meet the requirements of peanut laying and harvesting operation. It can provide a theoretical basis for the design of two-stage peanut harvesting device in the future.*

## 摘 要

*针对目前花生铺放作业机具中翻转装置相关研究较少且缺乏仿真参数的问题，本研究对直立型花生植株特性参数进行测定，试验输送翻转装置翻转秧蔓的可行性。通过研究花生植株力学特性，确定植株适宜夹持高度范围；通过研究花生植株的尺寸、质量参数及其分布规律，分析植株翻转掉落的可能性，确定输送翻转装置的主要结构与工作原理。基于 RECURDYN-EDEM 耦合开展输送翻转装置联合仿真，完成植株输送以及翻转过程的动态分析，进一步优化了模拟参数。试验结果表明，该装置可实现植株翻转完成度 95. 1%，田间晾晒质量提高，能够满足花生铺放收获作业要求，可为今后两段式花生收获作业装置的设计提供理论依据。*

## INTRODUCTION

Peanut is the most important oil crop and economic crop in China and even in the world (*China statistical yearbook, 2023*). At present, the mechanized harvesting methods of peanut are mainly divided into combined harvesting and two-stage harvesting (*Gao et al., 2017*). The first section of the two-stage harvest is mostly operated by digging and laying machines. After digging and removing the soil, the plants are laid in the field for drying for 3 to 5 days, and then the second section is collected. However, the field drying after the traditional two-stage harvest will result in a large difference in the moisture content of the upper and lower pods, which will greatly affect the subsequent picking and harvesting operations (*Chen et al., 2017*).

Domestic and foreign scholars have made some progress in the research of two-stage peanut harvester (*Guo et al., 2020*). *Bader et al., (2009*), analyzed the mass distribution characteristics of peanut plants and the movement characteristics during the inversion of vines, and realized the inversion of the elevated peanut vines on the ground. AMADAS company developed belt and rod conveyor structure, through the combination of large conveyor and vibration table roller, to ensure the quality of the harvest, but for the domestic peanut planting mode and farmers purchasing power it does not match (*Amadas Industries, 2022*). Pearman company has produced a peanut harvester, which uses clamping chain to lift peanut plants to remove soil, and realizes inertial lateral laying by laying guide rods, but it has poor adaptability to peanut planting mode (*Pearman corporation, 2022*).

In recent years, the research progress of two-stage peanut harvesting in China has been rapid. *Gao Lianxing et al.* proposed the 'flip-sliding fence' type laying method and designed the flip laying device of chain-stick peanut picker, which realizes the orderly laying of peanut plants 'head-to-tail' through the flip wheel device and the sliding fence-type plant gathering device. This is conducive to the subsequent operation after drying in the field (*Gao et al., 2016*). *Zheng Jinsong, (2022),* developed a peanut digging and inverted laying machine that uses a vibration digging mechanism, soil-conveying system, and turning-laying mechanism to complete the harvesting operation in a single pass. While the machine achieves a high degree of inverted placement, the harvested peanut plants contain more impurities, which can easily cause conveyor belt clogging and consequently reduce harvesting efficiency. *Zhou Quan et al.*, *(2022)*, proposed a shovel-chain low-laying peanut picker and harvester, which employs an extruding and dialing roller at the end of the digging device to lift and transport the peanut plants. Soil is then removed through shaking and vibration, ultimately achieving longitudinal laying with the roots positioned behind the seedlings.

To achieve the placement of peanut pods above the leaves after harvest, *Su, (2024),* investigated the turning behavior of peanut plants by studying their physical and mechanical properties, combined with conveyor turning device bench tests and discrete element simulation experiments. The objective was to explore the key factors and influencing mechanisms involved in successful peanut plant turning. *He et al., (2024),* further verified the optimal working performance of the conveyor turning device, aiming to provide a theoretical and technical reference for the development of two-stage peanut harvesting technology and equipment.

## MATERIALS AND METHODS

### *Overall Structure and Parameters of The Test Rig*

The overall structure of the conveying and tipping device is shown in Fig.1.

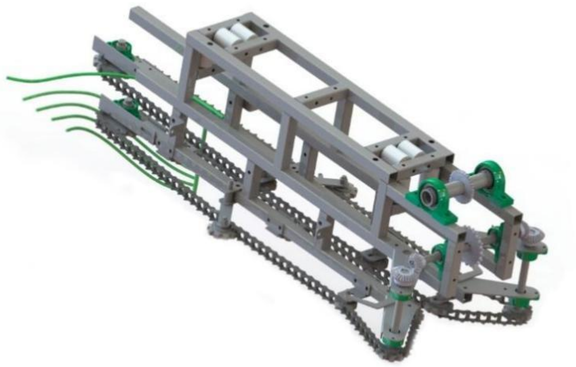


**Fig. 1 – 3D Conveying and tipping device test platform model**

The conveying and tipping device consists of components such as a rounding wheel, tensioning sprocket, vibrating wheel, guide grid, rounding grid, clamping chain, and others. During the clamping and lifting process, root-soil separation and final throwing of the peanut plants are achieved. The plants are first collected by the guide grid and then gradually lowered and laid down under their own weight as they pass through the collection grid.

**Table 1**

**Main Technical Data**

| *Parameter* | *Value* |
|---|---|
| Overall dimensions (length × width × height) (mm) | 1940×540×710 |
| Harvest method | Two-part |
| Horizontal inclination angle of clamping chain (°) | 20° |
| Clamping height (mm) | 140~170 |
| Clamping and conveying speed (km·h$^{-1}$) | 1.4 |

### Experiment Material Selection

The representative peanut variety "Huayu No. 25," commonly grown in Jiaozhou, Shandong Province, was selected as the experimental material. The crop was harvested in September 2024. The collected peanut plants were sealed in bags and brought back to the laboratory to prevent moisture loss. To better simulate the harvesting environment, the local planting pattern was measured, as shown in Fig.2.

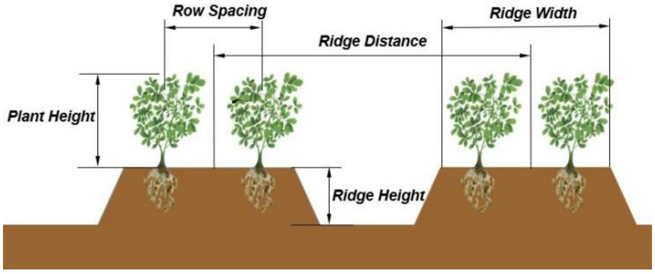



**Fig. 2 - Peanut planting pattern diagram**

### Size parameters and their distribution rules

The three-axis size parameters of peanut plants are necessary for the motion analysis of peanut plants and the establishment of discrete element simulation models of peanut plants. The three-axis dimensions of 50 peanut test samples were measured using a ruler, as shown in Fig. 3, and processed through data analysis software. The results are shown in Table 1.

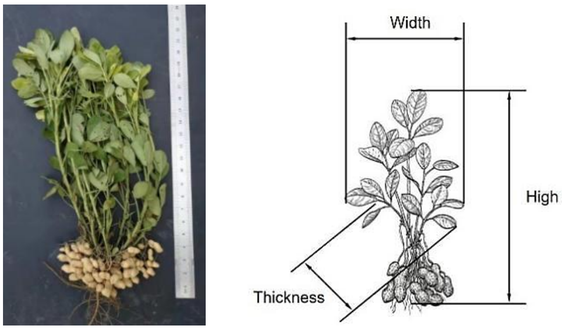



**Fig. 3 - Three-axis dimension calibration of peanut plant samples**

**Table 2**

**Peanut sample three-axis size data statistics**

| *Name* | *Average value* | *Standard deviation* | *95% confidence interval of mean* | | *Minimum value* | *Medium number* | *Maximum value* |
|---|---|---|---|---|---|---|---|
| | | | *Upper limit* | *Lower limit* | | | |
| Peanut plant height | 464.79 | 3.15 | 465.69 | 463.9 | 457 | 463.35 | 482 |
| Peanut plant width | 262.24 | 9.77 | 265.02 | 259.46 | 232 | 261 | 287 |
| Peanut plant thickness | 78.92 | 7.31 | 81 | 76.85 | 65 | 77.43 | 96 |

The normal distribution diagram is obtained based on the measurement results, as shown in Fig.4.

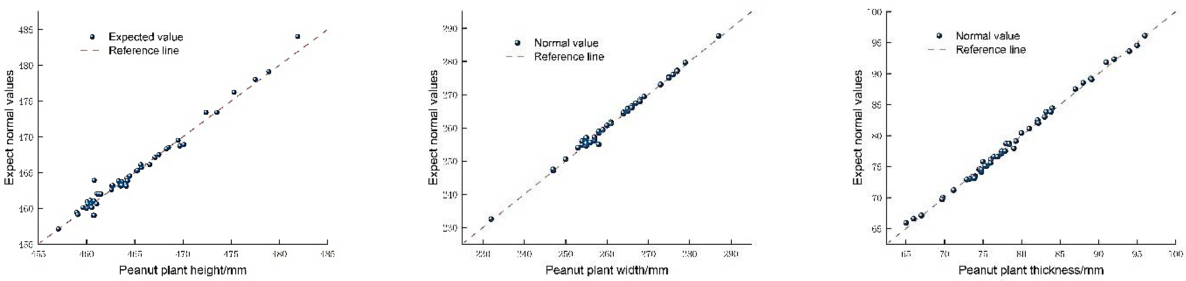



**Fig. 4 - Size distribution rules of peanut plant samples**

According to the above measurement results and statistical analysis, the height range of peanut plants is between 457 and 482 mm, with an average length of 464.79 mm. According to the statistical results, the standard deviation of the height of peanut plants is 3.15; the width of peanut plants ranges from 261 to 287 mm, with an average width of 262.24 mm. According to the statistics, the standard deviation of the width of peanut plants is 9.77; the thickness range of peanut plants is between 65 and 96 mm, with an average thickness of 78.92 mm. According to the statistics, the standard deviation of peanut plants is 7.31.

**Study on the material characteristics of peanut plants**

In order to study the flipping rules of peanut plants, it is necessary to analyze and determine the center of mass of peanut plants to provide data reference for the design of the conveying flip device.

Considering that in the actual peanut harvesting process, the peanut stalk, the pod, and the soil carried by the pod are a whole, a holistic study is conducted. In order to determine the position of the center of mass, the entire structure is assumed to be symmetrical, meaning the overall center of mass is located along the central axis of this symmetrical structure. The formula for calculating the centroid of peanut plants at harvest time was obtained, as shown in Figure 5.

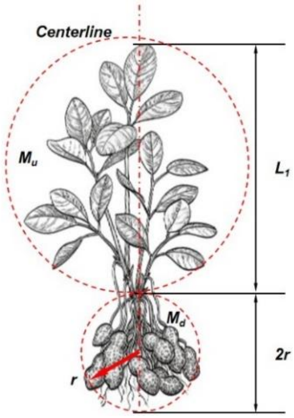



**Fig. 5 - Schematic diagram of the overall center of mass of peanut plants**

$$\bar{Y}=\frac{\sum M_n \cdot L_n}{\sum M_n}=\frac{M_u \cdot (L_1+2r)+M_d \cdot 2r}{M_u+M_d} \tag{1}$$

In the formula, $\bar{Y}$ represents the distance from the root of the seedling to the center of mass along the central axis of the peanut plant during the harvest period. $M_u$ denotes the mass of the above-ground portion, while $M_d$ represents the mass of the underground portion. $L_1$ is the height of the above-ground part of the peanut plant, and $r$ is the radius of the growth contour of the underground section of the plant.

In order to determine the above-ground part mass, underground part mass, above-ground part height and underground part growth profile radius during the harvest period, the sample needs to be measured multiple times to obtain an average value to explore the mass distribution of the above-ground peanut plants. The test results are shown in the Table 3.

**Table 3**

**Peanut sample three-axis size data statistics**

| Sample serial number | $L_1$(mm) | $M_u$(g) | $M_d$(g) | r(mm) | $\bar{Y}$(mm) |
|---|---|---|---|---|---|
| 1 | 342 | 335.6 | 290.1 | 59 | 301.43 |
| 2 | 338 | 340.3 | 298.4 | 56 | 292.09 |
| 3 | 324 | 320.8 | 291.5 | 63 | 295.75 |
| 4 | 360 | 352.1 | 315.6 | 50 | 289.83 |
| 5 | 346 | 327.5 | 322.7 | 52 | 278.28 |
| Mean | 342 | 335.26 | 303.6 | 56 | 291.48 |

Since the majority of a peanut plant's mass is concentrated in the underground portion, the center of mass is located closer to the rhizome. Based on the data in the table, the center of mass during the harvest period is found to be in the middle to lower part of the plant, near the rhizome. To ensure smooth flipping of the peanut plants when they come into contact with the bar, the seedling clamping height is controlled within the range of 140–180 mm.

**Determination of friction coefficient of peanut seedlings**

During the simulation analysis of the conveying and flipping motion of peanut plants, the friction coefficient plays a crucial role in determining the interaction between the peanut plants and both the clamping chain and the guide bar. The peanut plant serves as the primary subject of study; therefore, measuring its friction coefficient is of significant importance. *(Liu, 2022)*.

The rolling friction and static friction of peanut seedlings characterize their friction properties when in contact with solid surfaces. In the study, the material in contact with peanut seedlings was Q235 steel. The rolling friction and static friction between the seedling vines and the guide bar were measured.

This test uses the inclined method to measure the friction coefficient of peanut seedlings, and the test diagram is shown in Fig. 6.

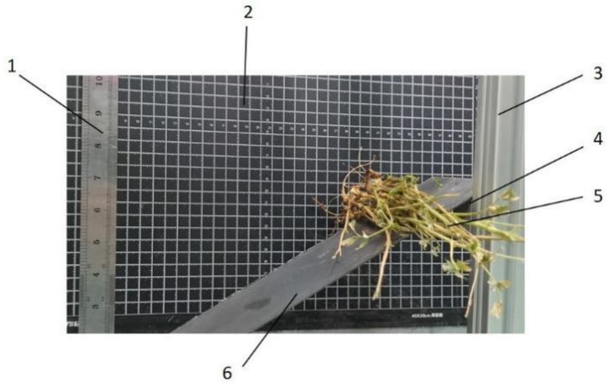



**Fig. 6 - Friction coefficient bench test**

*1. Scale ruler; 2. Square scale board; 3. Bench frame; 4. Lift platform; 5. Peanut seedling sample; 6. Contact material*

During the measurement test, the peanut seedlings are subjected to the support force $F_1$, the static friction force $f$ and their own gravity $G$ that is obliquely facing the seedlings. When the component force along the inclined direction is greater than the static friction force it is subjected to, the stem slides down along the inclined surface. From this, the static friction factor $\mu_1$ of the seedling and steel material can be obtained:

$$\mu_1 = \frac{f}{F_1} = \frac{G\sin\alpha_1}{G\cos\alpha_1} = \tan\alpha_1 \tag{2}$$

where $\alpha_1$ is the inclination angle of the test material.

Similarly, when determining the static friction coefficient $\mu_2$ between peanut seedlings, it is only necessary to replace the test material with peanut seedlings. Finally, the static friction coefficient $\mu_1$ between the peanut seedlings and Q235 steel is 0.44, and the static friction coefficient $\mu_2$ between peanut seedlings is 0.32.

**Rolling friction coefficient determination**

The tool used to measure the rolling friction coefficient of peanut seedlings is the same as that used for measuring static friction. The peanut seedling sample is approximated as a cylindrical object, and it is assumed that the resistance encountered during the rolling process arises solely from rolling friction. During rolling, the rolling friction torque $M_1$ is proportional to the normal force $F_2$ exerted on the contact surface. As the inclination angle of the slope gradually increases, the sample begins to roll. When rolling occurs, the stress conditions are illustrated in Fig. 7. The formula for calculating the rolling friction coefficient $\varepsilon$ is:

$$\varepsilon = \frac{M_1}{F_2} = \frac{G_1 r_1 \sin\beta}{G_1\cos\beta} = r_1\tan\beta \tag{3}$$

where $G_1$ is the gravity of the peanut seedling sample, $\beta$ is the angle at which the peanut seedling starts to roll on the contact material, and $r_1$ is the cross-sectional radius of the peanut seedling cross-section.

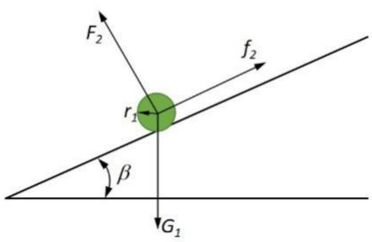



**Fig. 7 - Schematic diagram of stress during rolling of seedlings and vines**

The seedlings sample was placed on the inclined surface of the contact material of Q235 steel and the peanut seedlings for multiple tests, and the inclined angles $\beta_1$ and $\beta_2$ of the seedlings rolling were measured and recorded. The rolling friction between the peanut seedlings was calculated. The factor is 0.25, and the rolling friction coefficient between the peanut seedlings and steel is 0.13.

**Determination of shear modulus and Poisson's ratio in peanut plants**

A compression test was conducted using the XTC-18 Mass Composition Tester to determine the shear modulus and Poisson's ratio of peanut seedling samples. The test setup is shown in Fig. 8. The test parameters were as follows: test distance of 25 mm, loading speed range of 0.001~45 mm/s, test type set to downward pressure, trigger point type set to force, with a trigger point value of 5.000 gf. The target modes included pressure, displacement, and deformation. Prior to testing, the platform holding the sample was height-calibrated. The instrument was set to displacement mode, and the probe was programmed to press downward by a specified distance. After reaching the target value, the probe returned to its original position. The displacement value was set to exceed the height of the sample to ensure complete compression. A total of 30 peanut seedling samples were selected and divided into two groups of 15. One group was used for lateral compression tests, while the other group was used for longitudinal compression tests. Before testing, the transverse and longitudinal dimensions of all samples were measured and recorded.

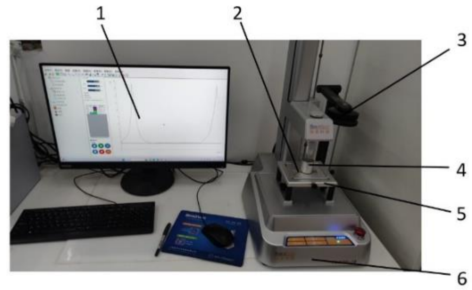



**Fig. 8 - Test bench for mechanical properties of peanut seedlings**

*1. Program interface; 2. Seedling sample; 3. Sensor; 4. Planar probe; 5. Platform; 6. XTC-18 mass composition tester*

The elastic modulus and Poisson's ratio calculation formulas of peanut seedling samples are:

$$\begin{cases} G_2 = \dfrac{E}{2(1+\mu_3)} \\ \mu_3 = \left|\dfrac{\Delta\varepsilon_x}{\Delta\varepsilon_y}\right| = \left|\dfrac{\Delta d_x d_y}{\Delta d_y d_x}\right| \end{cases} \tag{4}$$

where: $\mu_3$ is the Poisson ratio of peanut seedlings sample, $G_2$ is the shear modulus, $\varepsilon_y$ is the longitudinal strain, $d_y$ is the original longitudinal size, $\Delta d_x$ is the lateral deformation, $\Delta d_y$ is the longitudinal deformation, $\varepsilon_x$ is the lateral strain, $d_x$ is the original transverse size, and $E$ is the elastic modulus.

The calculation method of elastic modulus of peanut seedlings is:

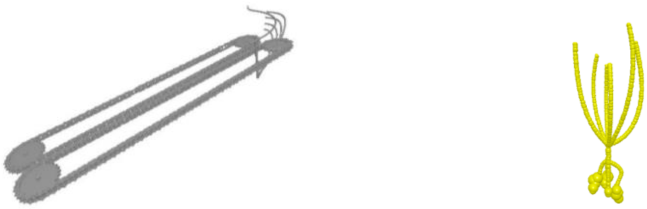
$$E = \frac{\sigma}{\varepsilon_y} \tag{5}$$

where $\sigma$ is the stress of the peanut seedling sample.

The compression test of peanut seedlings was repeated 15 times, and the results were statistically analyzed and averaged. The shear modulus interval of peanut seedlings was 18.13~18.15 MPa, and the Poisson ratio interval of peanut seedlings was 0.33~0.35.

**Dynamic simulation optimization analysis**

According to the above analysis, the peanut plants were simulated and a geometric model was established for conveying and flipping device (*Zhao et al., 2021*). However, the actual structure of the device was relatively complex. In order to save simulation calculation time, components that did not affect the simulation operation results were omitted, as shown in Fig. 9a.



*(a) Device simulation modeling* *(b) Peanut discrete element model*

**Fig. 9 - Emulation modeling**

Through the RECURDYN-EDEM coupling simulation optimization analysis, the specific setting parameters are shown in Table 4. The peanut plant particles were generated in EDEM, and the particles were imported into RECURDYN software to set the position and speed, and then the flip process was simulated and analyzed by the device in RECURDYN. The plant model is shown in Fig. 9b (*Zuo et al., 2022*).

**Table 4**

**Peanut discrete element modeling simulation parameters**

| Maximum feeding amount (kg/s) | Material generation rate (g/s) | Peanut plant height（mm） | Width（mm） | Result depth（mm） | Peanut plant size distribution |
|---|---|---|---|---|---|
| 4 | 1.95 | 460 | 260 | 95 | 0.9 ~ 1.1 |

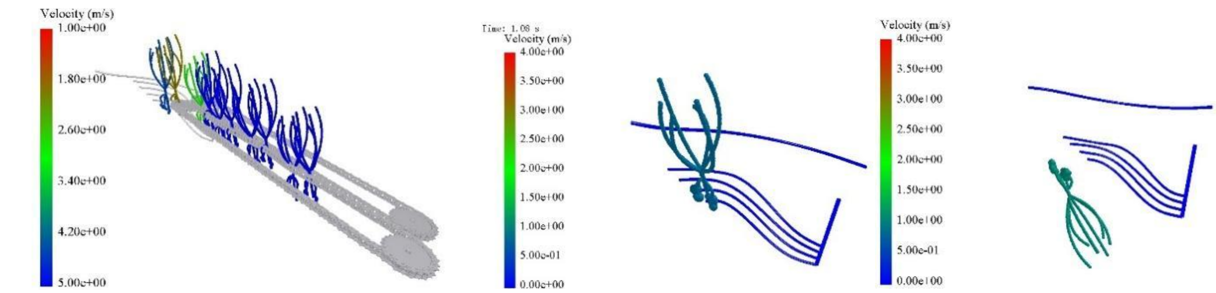
The Hertz-Mindlin (non-slip) contact model was adopted in order to study the regularities of peanut plant turnover and drop at the back end of the conveyor turnover device. During this process, peanut plant and peanut plant, peanut plant and clamp chain, peanut plant and guide rod were considered to be non-adhesive. (*Hao et al., 2021*). The materials and contact mechanical parameters related to peanuts and conveying and flipping devices are shown in Table 5.

**Table 5**

**Simulation material and mechanical parameters**

| Item | Parameter | Numerical value |
|---|---|---|
| Peanuts | Shear modulus (Pa) | $1.8×10^{7}$ |
| | Densities ($kg·m^{-3}$) | 450 |
| | Poisson's ratio | 0.35 |
| Steels | Shear modulus (Pa) | $7.9×10^{10}$ |
| | Densities ($kg·m^{-3}$) | 7865 |
| | Poisson's ratio | 0.3 |
| Peanuts - Peanuts | Coefficient of restitution | 0.5 |
| | Static friction coefficient | 0.32 |
| | Rolling friction coefficient | 0.25 |
| Peanuts - Steel | Coefficient of restitution | 0.42 |
| | Static friction coefficient | 0.44 |
| | Rolling friction coefficient | 0.13 |

The movement parameters of the conveying and flipping device include the conveying speed, the gripping height of the seedlings and the impact angle between the seedlings and the bar (*Chen et al., 2023*). A one-factor test was performed on each motion parameter. The RECURDYN-EDEM coupling simulation process is shown in Fig.10. The impact angle between the seedlings and the bar is 18°, 19°, 20°, 21°, 22°; the conveying speed is 1.2, 1.3, 1.4, 1.5 and 1.6 m/s; the clamping height of the seedlings is 140 mm, 150 mm, and 160 mm , 170 mm and 180 mm.




*(a) Peanut conveying process simulation diagram* *(b) Peanut flipping process simulation diagram*

**Fig. 10 - Directional turnover peanut harvest device simulation flow chart**

### Analysis of data results

According to the analysis of simulation process, the gripping height of peanut plant X1, the impact Angle of peanut plant X2 and the conveying speed X3 were tested by experimental factors. The degree of peanut flipping completion Y was used as the evaluation index. A 3-factor, 3-level orthogonal testing method was employed to design the experiments *(Xie et al., 2024)*. The factor coding is shown in Table 6.

**Table 6**

**Test factor coding table**

| Encodings | Factor | | |
|---|---|---|---|
| | $X_1$ (mm) | $X_2$ (°) | $X_3$ ($m\cdot s^{-1}$) |
| -1 | 140 | 18 | 1.2 |
| 0 | 160 | 20 | 1.4 |
| 1 | 180 | 22 | 1.6 |

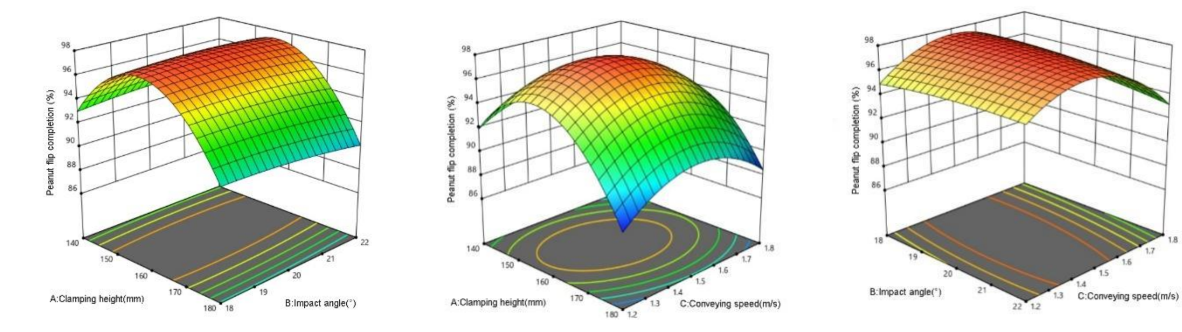
The test scheme and results are shown in Table 7.

**Table 7**

**Test factor coding table**

| Encodings | Factor | | | Peanut flip completion |
|---|---|---|---|---|
| | $X_1$ (mm) | $X_2$ (°) | $X_3$ ($m\cdot s^{-1}$) | |
| 1 | 140 | 18 | 1.4 | 93 |
| 2 | 180 | 18 | 1.4 | 91.4 |
| 3 | 140 | 22 | 1.4 | 93.4 |
| 4 | 180 | 22 | 1.4 | 90.2 |
| 5 | 140 | 20 | 1.2 | 91.9 |
| 6 | 180 | 20 | 1.2 | 88.2 |
| 7 | 140 | 20 | 1.6 | 89.1 |
| 8 | 180 | 20 | 1.6 | 88.5 |
| 9 | 160 | 18 | 1.2 | 94.8 |
| 10 | 160 | 22 | 1.2 | 95.2 |
| 11 | 160 | 18 | 1.6 | 94.6 |
| 12 | 160 | 22 | 1.6 | 93.2 |
| 13 | 160 | 20 | 1.4 | 97.4 |
| 14 | 160 | 20 | 1.4 | 97.6 |
| 15 | 160 | 20 | 1.4 | 97.7 |
| 16 | 160 | 20 | 1.4 | 97.1 |
| 17 | 160 | 20 | 1.4 | 97.9 |

The response surface analysis of the test results was carried out by Design-Expert13.0.1.0 software, and the influence of each test factor on the completion degree of peanut flipping was obtained, as shown in Fig.11. It can be seen that when the clamping height is 156.8 mm, the conveying speed is 1.47 m / s, and the impact angle is 20.24 °, the peanut flipping completion degree is up to 98.1% (*Zhang et al., 2024*). With the increase of the impact angle between the vine and the grid, the chain clamping peanut vine is more unobstructed, which is convenient for the smooth turnover of the plant. With the increase of vine clamping height, the peanut flip completion degree showed a trend of increasing first and then decreasing, and the influence was the most obvious among the three factors. With the increase of conveying speed, the completion degree of peanut flipping showed a trend of increasing first and then decreasing (*Zhang et al., 2022*).




*(a) The interaction of A and B factors* *(b) The interaction of A and C factors* *(c) The interaction of B and C factors*

**Fig. 11 - Response surface analysis of peanut turnover completion**

According to the harvest demand of peanut turnover completion degree and the boundary of test factors, combined with the analysis results of related models, the constraints of the optimal solution are as follows:

$$\begin{cases} \min \ Y_1(x_1, x_2, x_3) \\ s.t \begin{cases} 140mm \le x_1 \le 180mm \\ 1.2\text{m/s} \le x_2 \le 1.6\text{m/s} \\ 18° \le x_3 \le 22° \end{cases} \end{cases} \tag{6}$$

Through the optimization scheme, when the clamping height is 160 mm, the clamping and conveying speed is 1.4 m/s, and the impact angle between the vine and the grid is 20°. It is the optimal combination parameter, and the peanut turnover completion degree is 96.1% (*Zhang et al., 2022*).

## RESULTS

### Field test of the device

The installation structure diagram of the conveying and flipping device bench is shown in Fig.12a.

*(a) Bench test*

*(b) Field test results*

**Fig. 12 - Directional flipping peanut harvesting device test diagram**

The feasibility of bench test design is established. After the data is optimized, it is installed on the whole machine for field testing, as shown in Fig. 12b. According to the theoretical prediction value of each factor and the actual operation situation, the vine clamping height was 160 mm, the conveying speed was 1.4 m/s, and the impact angle was 20°. Under the same test conditions of the quadratic multiple regression analysis test, three repeated tests were performed and the average value was taken. By counting the completion of peanut flipping and analyzing the moisture content of peanut pods in the field after flipping, the feasibility of peanut flipping and whether the quality of drying after flipping was improved were tested (*Chen et al., 2024*).

Compared with the traditional peanut unidirectional lateral orderly placement machine, it is better to realize the turnover and placement of peanuts on the ground after harvest, allowing for more thorough drying in the field. The higher the degree of peanut turnover, the better the field drying effect, and the lower the moisture content of peanut pods. The peanut flip completion degree and prediction results are basically the same as shown in Table 8, which is more in line with the requirements of two-stage peanut harvest.

Under identical drying conditions, the moisture content of peanut pods from the two different laying methods was compared after three days of drying.

**Table 8**

**Comparison of peanut flipping completion**

| Parametric | Peanut flip completion |
|---|---|
| Projected value | 96.1% |
| Experimental value | 95.1% |

The peanut moisture content data of the experiment were visualized to form a line chart, as shown in Figure 13.

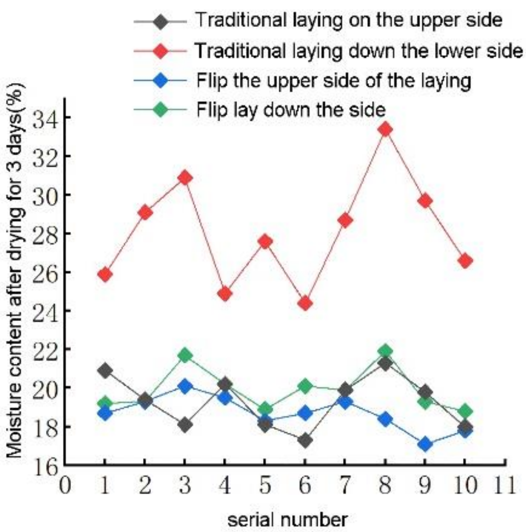



**Fig. 13 - Peanut pod moisture content comparison chart**

According to the experimental results, the highest value of peanut flip completion is 96.9 %, the lowest value is 92.7 %, and the average value is 95.1%. After 3 days of drying, the highest moisture content of the upper peanut pod was 19.8%, the lowest was 16.7%, and the average was 18.1%. After 3 days of drying, the highest moisture content of the lower peanut pod was 20.9%, the lowest was 18.5% and the average was 19.1%. Compared with the traditional peanut harvester, the harvesting efficiency and the drying quality of peanut in the field were further improved.

## CONCLUSIONS

(1) Aiming at the problems of poor field drying quality and long harvest cycle of traditional two-stage peanut after harvest, an optimized laying method was proposed, and a conveying and turning device was designed. Peanut plants were turned down and laid on the ground to improve the quality of field drying.

(2) Through the analysis of the physical and mechanical properties of peanut plants, the feasibility of flipping was assessed. After the measured parameters were brought into the coupling simulation, the mathematical model of the relationship between test factors and indicators was established by Design-Expert software. The response surface method was used to study the law of peanut turnover completion.

(3) The performance of the equipment was tested. Under the optimal parameter combination, the harvest efficiency and harvest quality of the field experiment were tested.

## ACKNOWLEDGEMENT

This research is supported by the national Natural Science Foundation of China Youth Science Foundation Project (52405278); Natural Science Foundation of Shandong Province Youth Science Fund Project (ZR2024QE377); funded by the National Key R & D Program (2022YFD2300100).

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