

Rice Harvesting General Commends

Prof. Chen Shuren

School of Agricultural Engineering, Jiangsu University,
Zhenjiang ,China
E-mail:srchen@ujs.edu.cn



CONTENTS

- 01 Background
Introduction
- 02 General Commends
- 03 Reaper and
Paddy Pickup
- 04 Rice combine harvest

01

Background Introduction





Rice is one of the three major global food crops and provides an important source of food for the global population. Especially in Asia and Africa, rice is the main food crop in many countries, meeting the daily food needs of billions of people.



Rice harvesting is of great significance in reducing food shortages and improving people's diet and nutritional status. The rice harvest has also driven the development of agriculture and related industries.

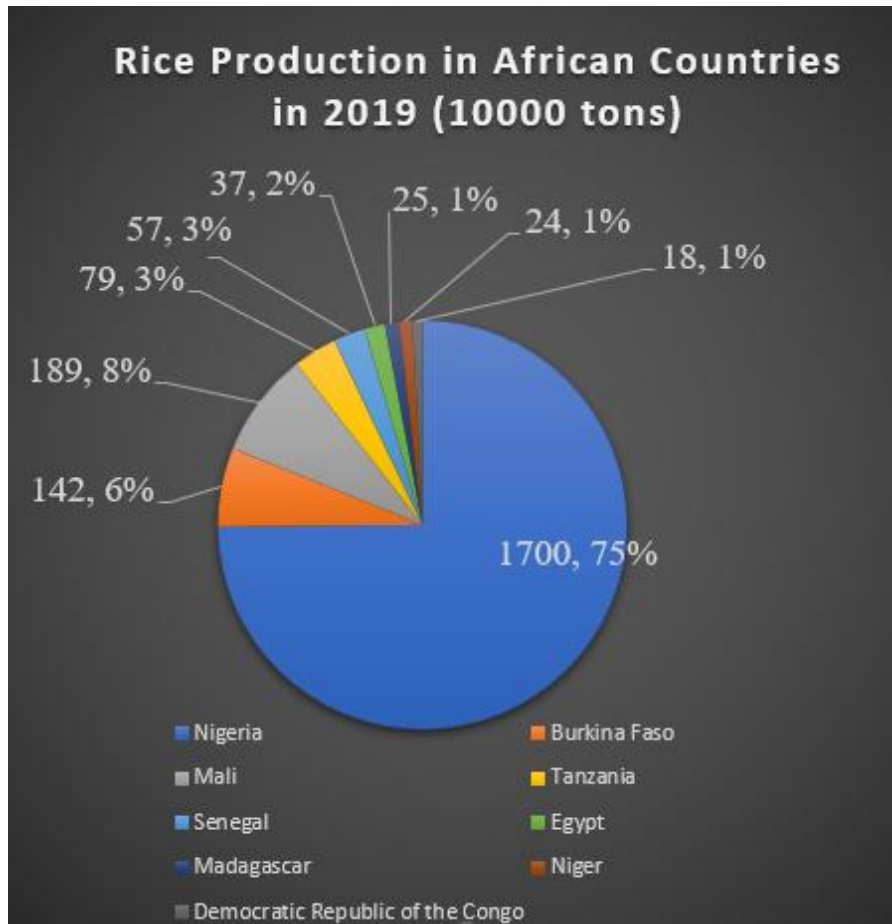


Top 10 Rice Producing Countries in the Water World

Rank	Country	2021 Rice Production (tons)
1	China	212,843,000
2	India	195,425,000
3	Bangladesh	56,944,554
4	Indonesia	54,415,294
5	Viet Nam	43,852,729
6	Thailand	33,582,000
7	Myanmar	24,910,000
8	Philippines	19,960,170
9	Pakistan	13,984,009
10	Brazil	11,660,603

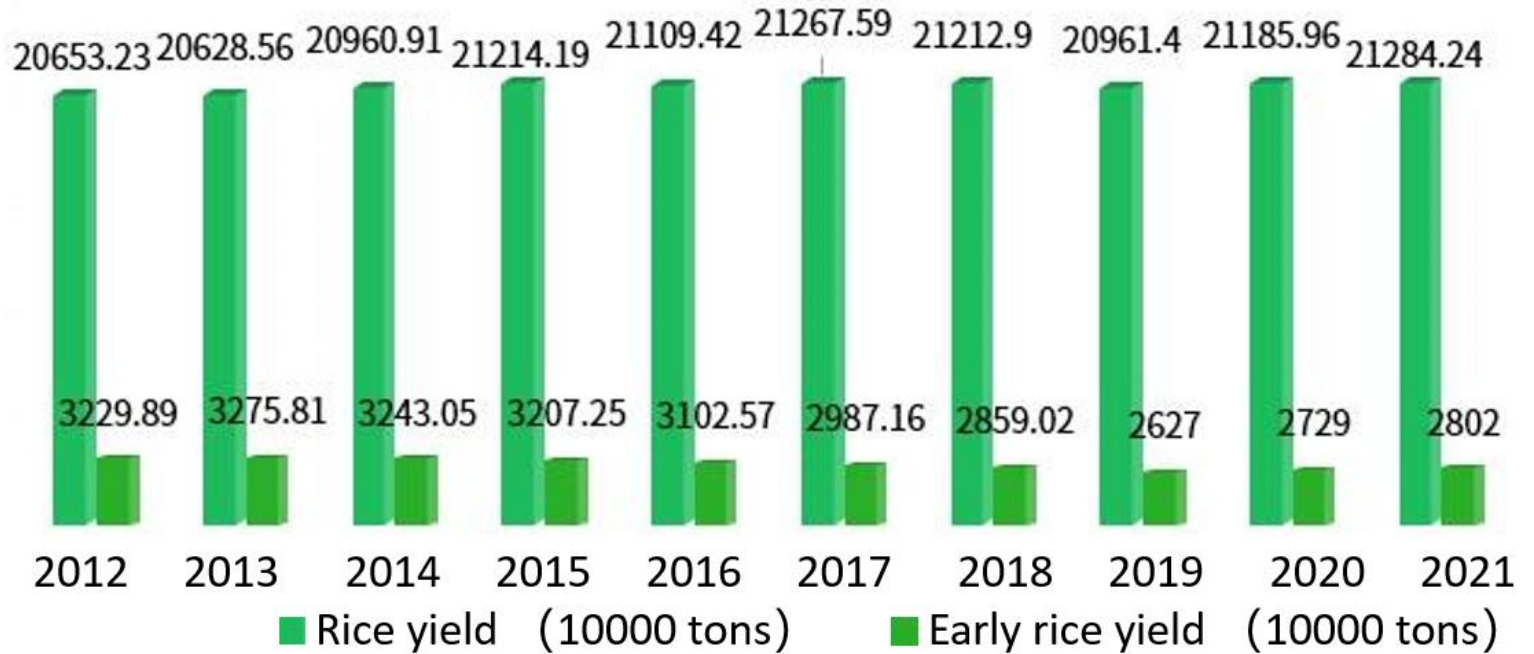
Rice cultivation in Africa has a smaller scale and lower yield.

But overall, there is still room for improvement in rice production in Africa.



The rice yield in Africa is relatively low, but some countries are actively promoting agricultural development to improve food self-sufficiency.

China's Rice Yield Chart from 2012 to 2021



According to the data of the Food and Agriculture Organization, China is the largest rice producer in the world.

Artificial harvesting rice



Artificial transportation of rice



Wooden manual threshing machine



Semi-automatic cutting machine



Semi-automatic thresher



Combine-harvester



Comparison of Rice Harvest Times

Area	Africa (common countries)	China
Harvest time	June to November	August to October
Main Season	Late dry season	Autumn
Climate condition	Tropical and subtropical climate	Varies by region, including subtropical, and temperate



Rice is too mature

Rice is a kind of crop prone to decay and insect pests. Timely harvesting can reduce food loss and waste. If the harvesting time is delayed, rice may become overly mature and be affected by pests and diseases. Rice can be harvested when the ripening rate reaches over 95%.



02

General Commends



INTRODUCTION

Harvesting purpose : to recover grains from the field and separate them from the rest of the crop material.

The methods and equipment used for harvesting depend upon the type of grain crop, planting method, and the soil conditions.

For paddy harvest, the head feed combine is more suitable.

◆ Rice harvester machine



Hand-held rice harvester

◆ Rice harvesting machine



Rice harvesting



Half feed rice threshing



Full feed rice threshing



Half feed rice combine



Full feed rice combine

INTRODUCTION

Harvesting is the last stage of rice crop production.

Timely harvesting ensures good grain quality, less broken grain and higher germination rate.

Rice losses will increase if the crop is not harvested in time.

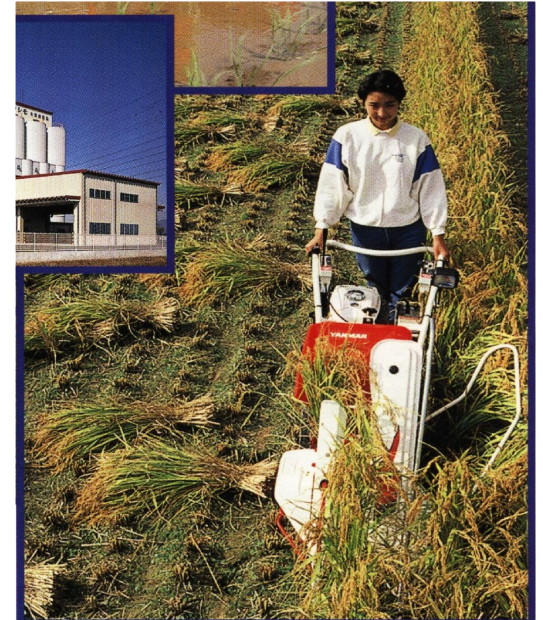
The machines for harvesting rice can be classified :

- ❑ **Reaper:** reaper -windrower, reaper bundler etc.
- ❑ **Thresher:** whole feed thresher and head feed thresher.
- ❑ **Combine Harvester:** whole feed combine harvester ,
Head feed combine, Mounted-type rice combine.



03

Reaper and Paddy Pickup



Reaper and Paddy Pickup

- A mechanical reaper is an agricultural device which reaps crops mechanically and lays down the stems into small bundles, providing an alternative to using laborers to gather in crops by hand at harvest time.
- Mechanical reapers can be classified into two types according to the positions of cutting table and conveying devices: horizontal conveying reaper and vertical conveying reaper.

Rice reaper -windrower Powered by tractor

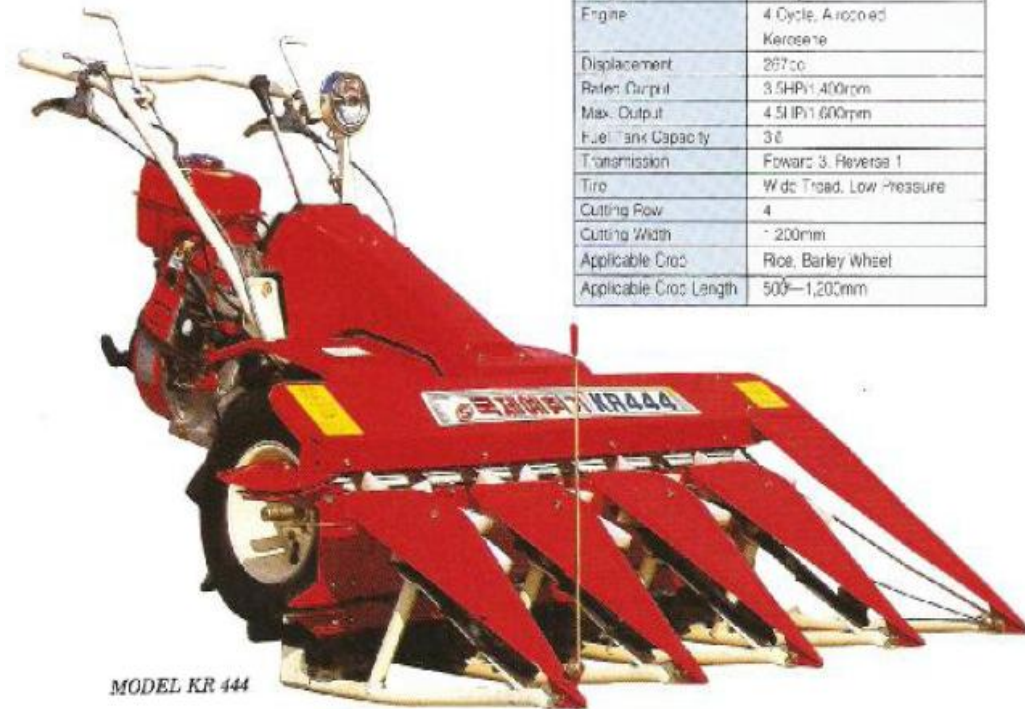
- Reaper -windrower :
- Vertical conveyor reaper are light weight, simple construction, and easy of front-mounting on small two-wheel tractor.

Reaper

1. Economical up-keep
2. Higher workability by 4 rows
3. Simpler operation & maintenance
4. Easier manuvability by wide treadive

SPECIFICATIONS

Model	KR-44
Dimensions (LxWxH)	~ 750x1,500x1,020mm
Weight	~ 50kg
Engine	4 Cycle, Aircooled Kerosene
Displacement	297cc
Rated Output	3.5HP(1,400rpm)
Max. Output	4.5HP(1,600rpm)
Fuel Tank Capacity	3ℓ
Transmission	Forward 3, Reverse 1
Tire	Wide Tread, Low Pressure
Cutting Row	4
Cutting Width	~ 200mm
Applicable Crop	Rice, Barley, Wheat
Applicable Crop Length	500~1,200mm



MODEL KR 44

Reaper binder





Chinese Reaper



Thai Reaper

Reaper binder



Reaper binder is a machine that the crops pass the divider board, reel and they are cut by cutter. They are carried into binder and bundled up by ropes. After that they are put to one side of the machine.

INTRODUCTION

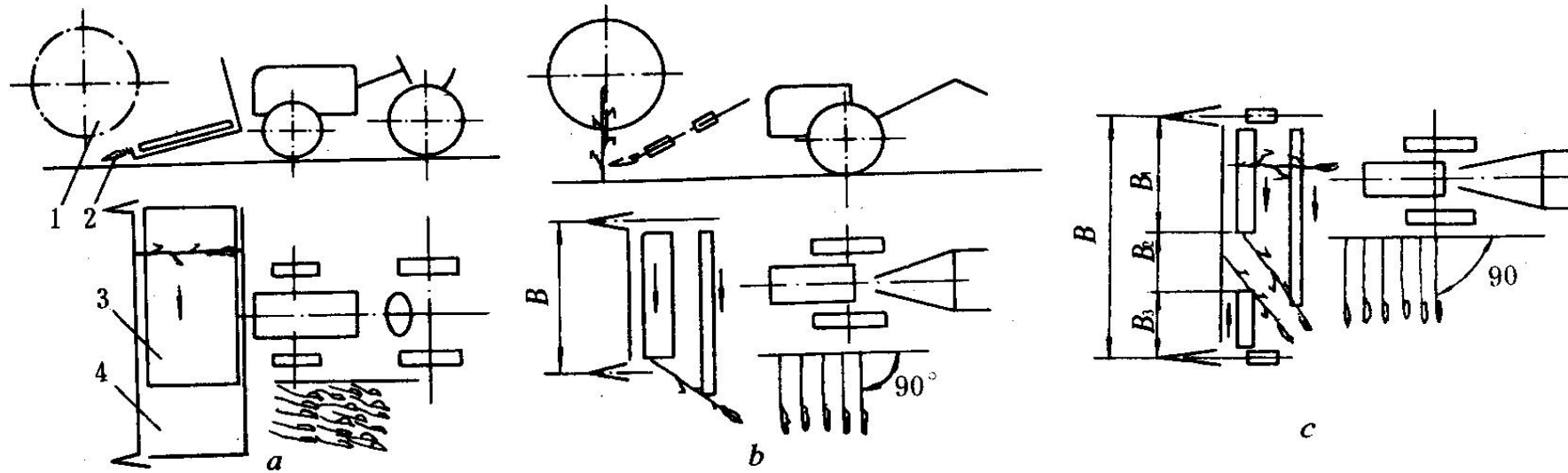


Three types of rice reaper

Horizontal conveying reaper

- Featuring a horizontal cutter and bigger cutting width, the horizontal conveying reaper has good operational reliability. Most reapers with big cutting width adopt this configuration.
- Horizontal conveying reapers can be further classified into several models, namely, single conveyor belt, double conveyor belt and multi-conveyor belt as the number of conveyor belts varies.

Schematic diagram of horizontal conveying reaper



a. single conveyor belt b. double conveyor belt c. multi-conveyor belt

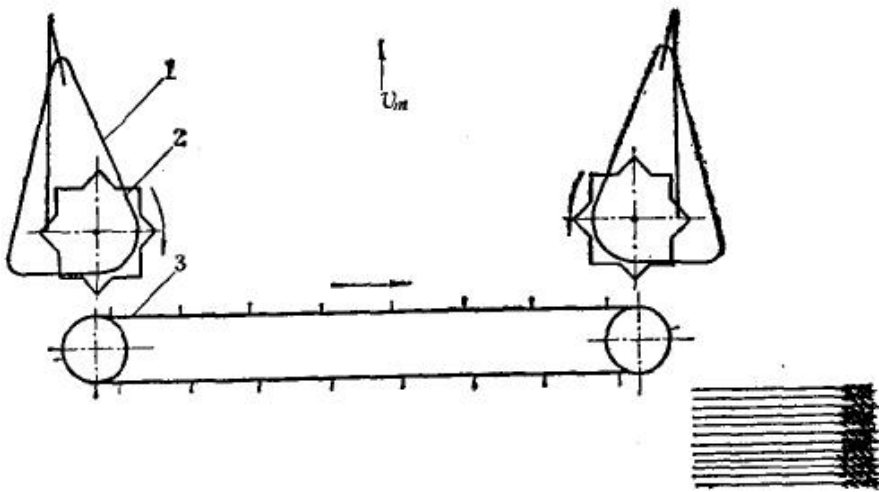
When horizontal conveying reaper operates, the reel, conveyor belt and cutter are driven by the engine. Guided to the cutting area by grain divider and backward movement of reel, the paddy is cut, with the straw piled in field via conveyor belt.

Vertical conveying reaper

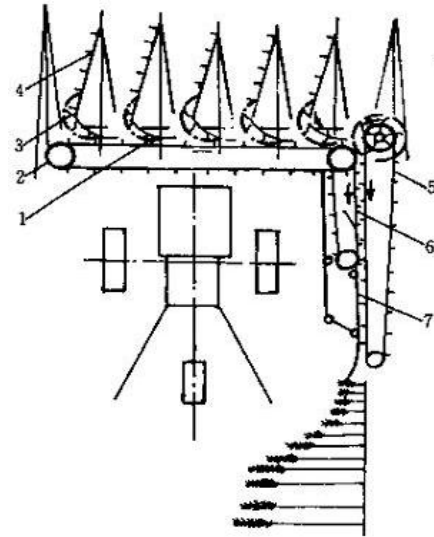
Vertical conveying reaper is a mechanical reaper whose cutting table position is vertical. When the vertical cutting table works, the standing paddy is cut, then transported by conveyor and finally laid down in field.

It has the characteristics of light weight, compactness and high mobility, therefore suitable to use in scattered small fields while inappropriate for harvesting lodging paddy.

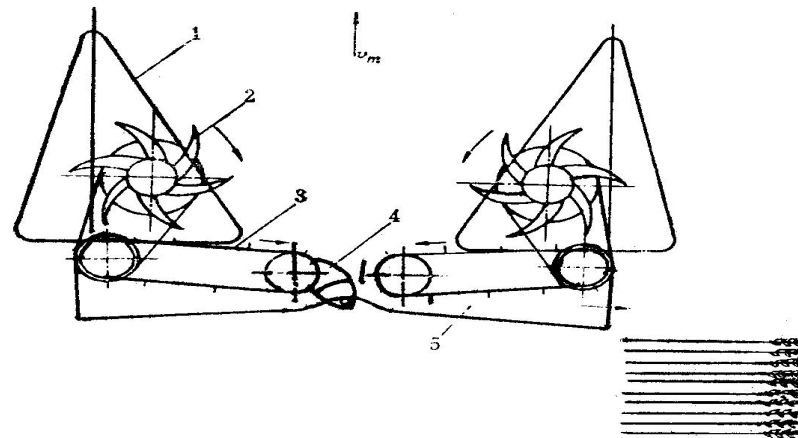
Schematic diagram of side-delivery and back-delivery reaper



1-grain divider 2-star wheel
3-conveyor belt

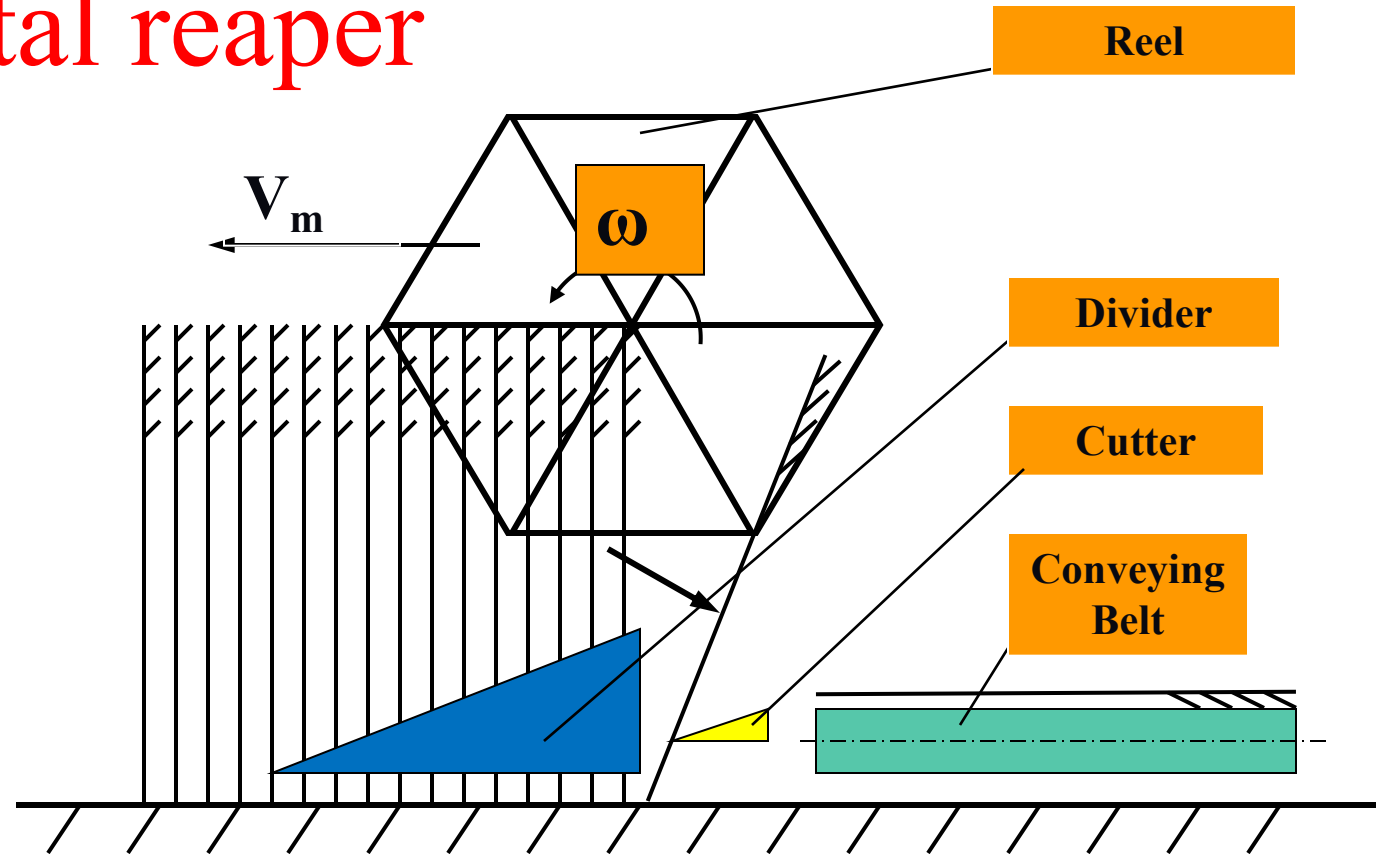


Back windrowing



1.divider 2-stalk lifter 3-conveyor belt 4-commutating valve

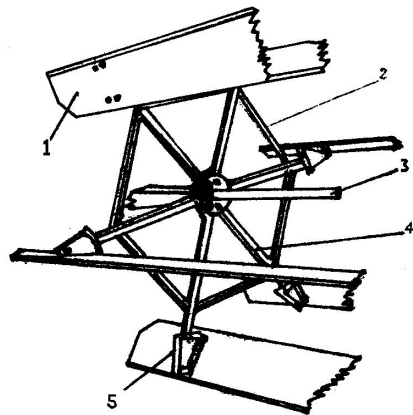
Horizontal reaper



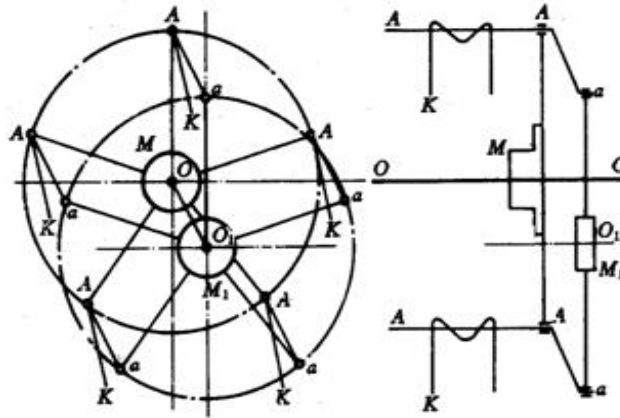
Basic Component : Divider, Reel, Cutter, Conveying, Transmission

Revolving reel

The function of revolving reel is to lead paddy stem to cutter, support the stem, push the cut paddy into conveyer belt, clean the cutter table, prevent the cut stem from accumulating on the cutter knife. Revolving reel is divided into two kinds, the normal one and the eccentric one.



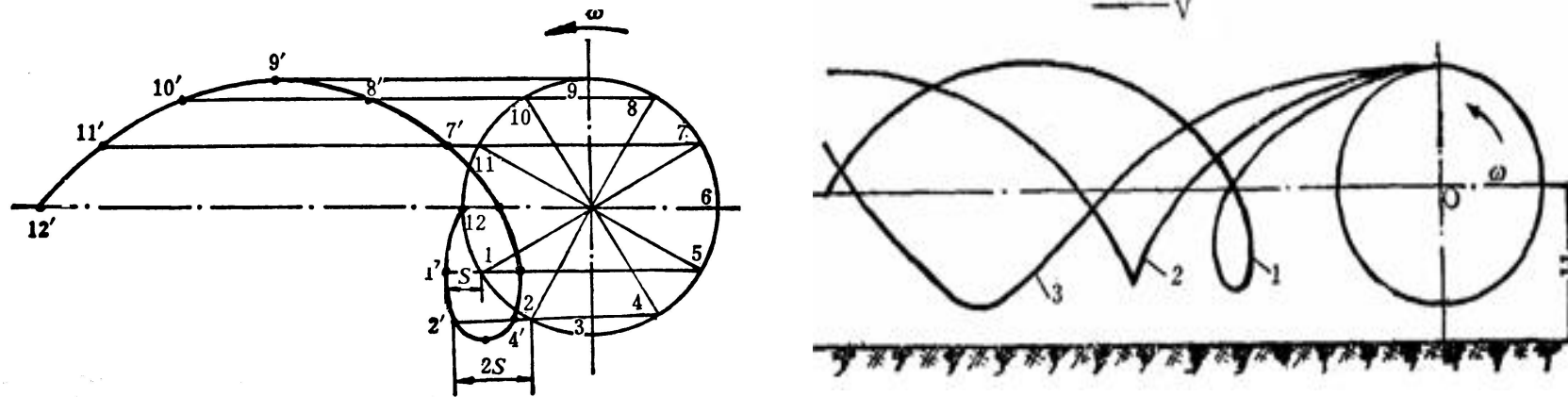
Normal reel



Eccentric reel

Eccentric revolving reel consists of wheel axle, spoke, tendon, chain wheel, press layer and spring tooth.

The motion trace of reel bat



The trochoidal curve motion path of reel bat is composed of revolving circle speed V_b and combine forwards speed V_m . The motion trace depends on the ratio λ of V_b to V_m . Only when the $\lambda > 1$, the motion trace has the trochoidal curve. There is the backwards horizontal speed under the trochoidal curve for pushing the paddy action. So the necessary condition is $\lambda > 1$ for the revolving reel working normal.

Mini-type Paddy Reaper



Technology parameters:

Weigh: 8.8KG

Engine: 1E40F Gasoline
Engine

Displacement: 42.7CC

Power: ≥ 1.25 KW

Paddy reaper by hand operation

INTRODUCTION



Two kinds of reaper

Agricultural Technological requirements

Technological requirements for mechanical reaping are listed as follows:

1. Clean harvest and decrease grain losses.
2. Lower stubble length, which will be convenient for next round of stubble plough.
3. Orderly stacking of straw for the convenience of picking up, without disturbance upon neighboring fields.
4. Good adaptability to different crops or fields.
5. Harvest in time.

◆ Reaper



◆ Self-binder



◆ Thresher



◆ Small combine harvester

Small combine harvesters suit for hilly fields

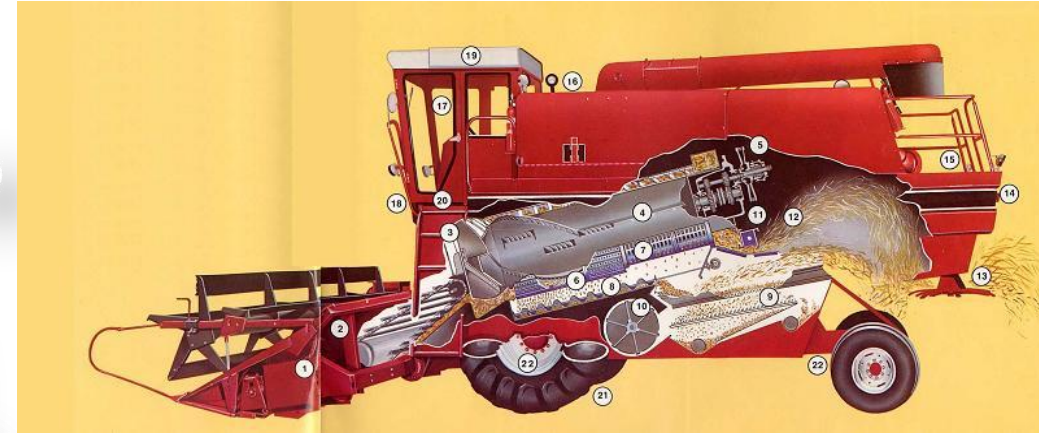
Feature: feed rates 0.5-1Kg/s, simple structure, hilly field

Structure: Wheel or crawler tracks, small rotors



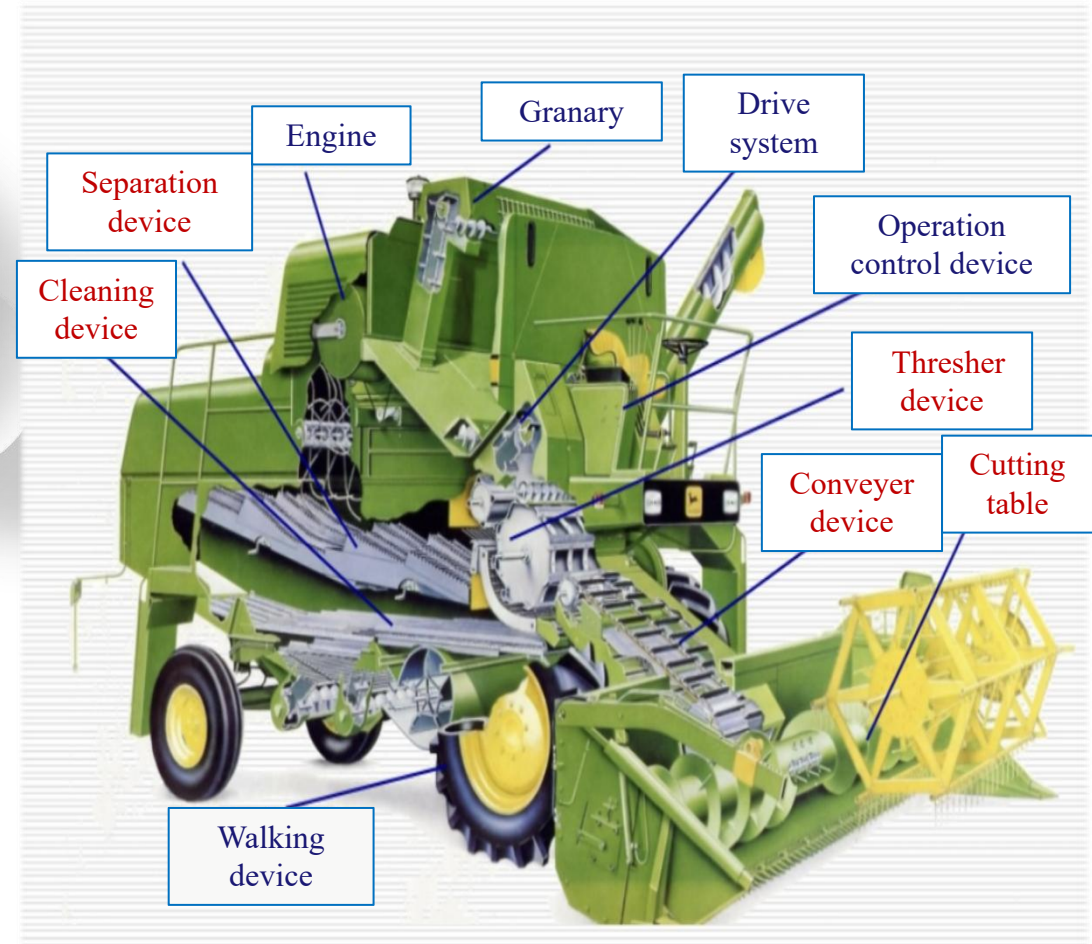
04

Rice combine harvest



Rice combine harvest

The harvester and thresher are organically combined into one operating machine through the intermediate conveyor, transmission device, walking device, operation and control device, etc., and a single operation simultaneously completes a number of operations such as crop harvesting, threshing, separating, clearing and straw treatment, so as to obtain relatively clean grains.



Rice combine harvest

As a harvesting machine that combines four separate operations (reaping, threshing, separating and cleaning) into an integral operation processes, the combine harvester, or simply combine, can applied to harvest paddy, wheat and corn. The harvest residue abandoned in the field includes the processed stem and leaves of the crop with limited nutrient, which can be either bound to feed or mattress livestock.

Features of Rice Combine Harvesters

1. High productivity
2. small total loss of harvest
3. high degree of mechanization, can be completed in one harvest, threshing, separation and cleaning operations
4. complex machine structure, expensive, high operating costs
5. only when the grain reaches the end of maturity to give full play to its high efficiency
6. harvesting time is short, low utilization of the machine throughout the year

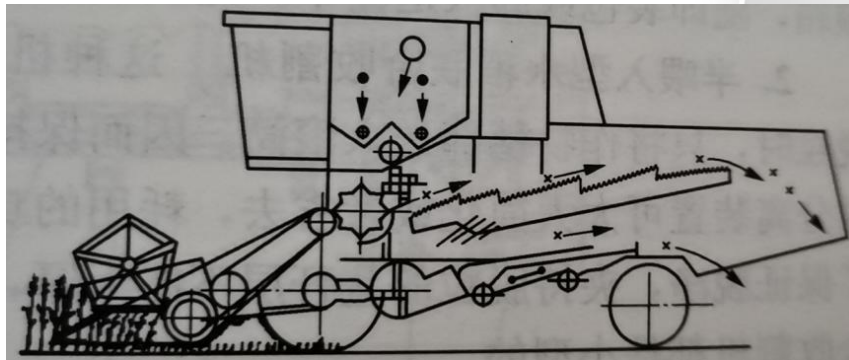
Agricultural Technological requirements

Technological requirements for rice combine harvest are listed as follows:

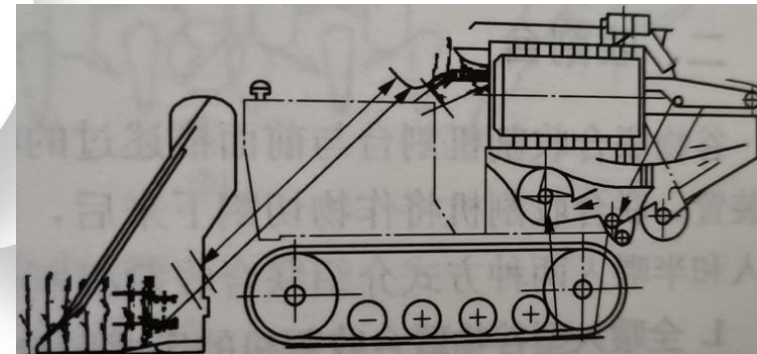
1. total harvesting loss of no more than 2% (total loss includes cutting table loss, threshing loss, separation loss, cleaning loss, of which the cutting table loss, including missed loss, blow loss, loss of ears)
2. grain crushing rate: wheat $\leq 1.5\%$, rice $\leq 1\%$
3. grain cleanliness: wheat $\geq 98\%$, rice $\geq 93\%$
4. stubble height: generally $\leq 15\text{cm}$ (straw to the field)
5. machine adaptability, can harvest a variety of crops
6. machine structure is simple, reliable, durable, easy to adjust and maintain, good maneuvering performance

Classification of grain combine harvesters

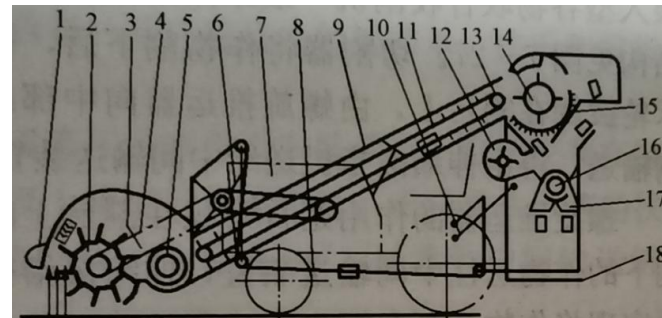
1. Classification by grain feeding method:



(1) Whole feed combine



(2) Head feed combine



(3) pre-cut threshing (Academician Jiang Yiyuan)

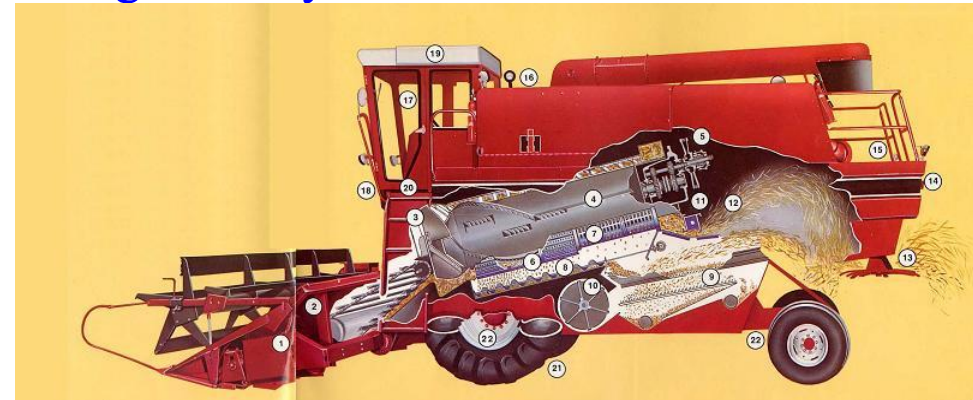
Classification of grain combine harvesters

1. Classification by grain feeding method:

- (1) **Whole feed combine:** ① Grain all fed into the threshing device for threshing, and complete the separation, cleaning operations;
- ② according to the way the grain through the threshing drum, can be divided into tangential flow, axial flow two kinds;
- ③ combine harvester threshing drum traditional type for tangential flow, more applications, power consumption, cleaning and separation of the difficulty of large, large models;
- ④ part of the combine harvester using axial flow threshing drum, eliminating the drafter, the machine longitudinal dimensions of the smaller, better generality.



tangential flow



axial flow

Classification of grain combine harvesters

1. Classification by grain feeding method:

(1) Whole feed combine:

◆ tangential flow:

Tangential threshing drum + transverse axial separation drum (Xinjiang-2)

Tangential threshing drum + longitudinal axial separation drum (John Deere 3518)



Xinjiang-2



John Deere 3518

◆ axial flow:

Transverse Axial Threshing-Separating Drum (Zhujiang-1.5, Huzhou-130, Futian 4LD-2)

Longitudinal axial threshing-separation drums (CASE2388 (single flow drum), New Holland 23TR88)



4LD-2



CASE2388

Classification of grain combine harvesters

1. Classification by grain feeding method:

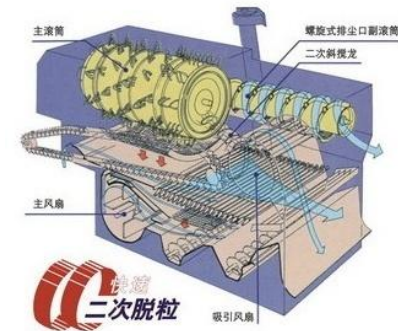
- (2) **Head feed combine** :
- ① The gripping conveyor unit grips the grain stalks traveling in the direction of the drum axis, and only the head portion is fed into the drum for threshing;
 - ② Stalks do not enter the threshing unit, low power consumption and stalk integrity;
 - ③ High requirements for stalk neatness during threshing, low threshing speed, affecting the productivity of the machine;
 - ④ Semi-feeder units are mainly used in small rice combine harvesters.



Kubota head feed



Yanmar CE1 crawler head feed rice combine harvester



Rapid secondary threshing and cleaning device

Classification of grain combine harvesters

1. Classification by grain feeding method:

(2) Head feed combine :



Head feed rice combine harvesting



Driverless harvesting operations

Classification of grain combine harvesters

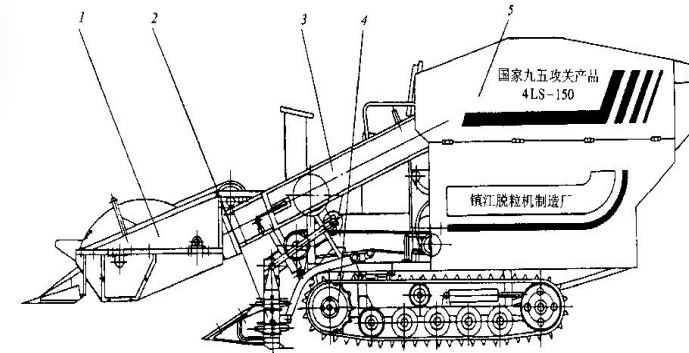
1. Classification by grain feeding method:

(3) **Comb-off type(pre-cutting off):** ①The organization is simple, small power consumption, high efficiency, but the threshing splash loss is large, not suitable for fallen crops, adaptability, reliability has not yet been resolved.

②Combing and cutting device instead of conventional cutting table



4LS-150 comb-off self-propelled combine harvester operation

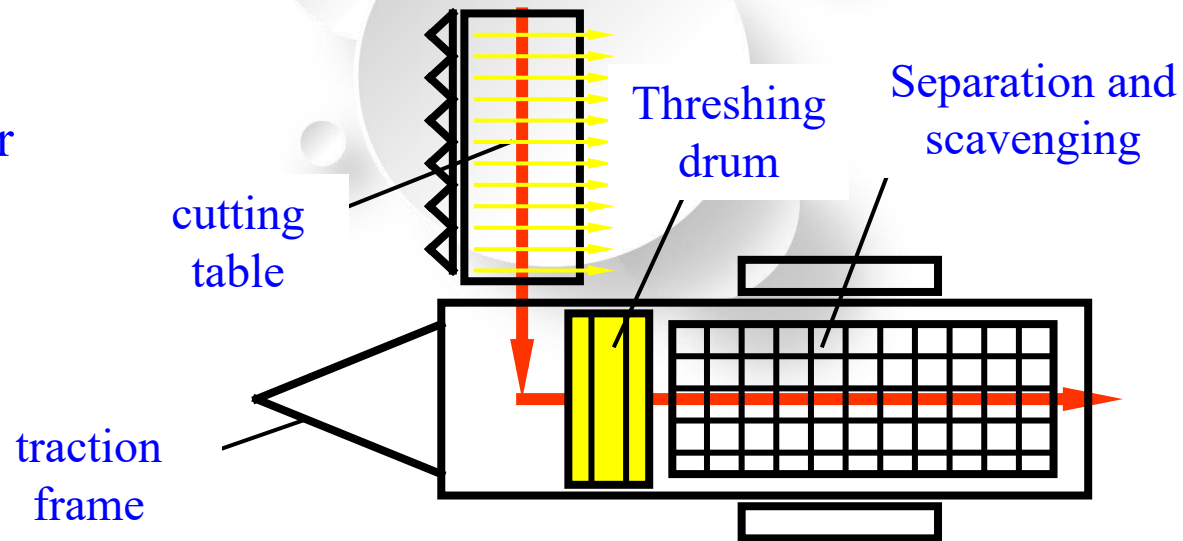


Pre-cutter threshing combine harvester
1. dressing table 2. Stalk cutting and spreading device 3. Conveyor 4. Chassis 5. Reworking and cleaning device

Classification of grain combine harvesters

2. Classification by power supply method: Tractor, self-propelled, Hanging

(1) Tractor harvester



Tractor type - work by the tractor to pull forward. Characteristics: simple structure, low price, high power utilization rate of the unit. The disadvantage is that the unit is huge, poor maneuverability, can not open the road by itself.

Classification of grain combine harvesters

2. Classification by power supply method: Tractor, self-propelled, Hanging

(2) self-propelled harvester

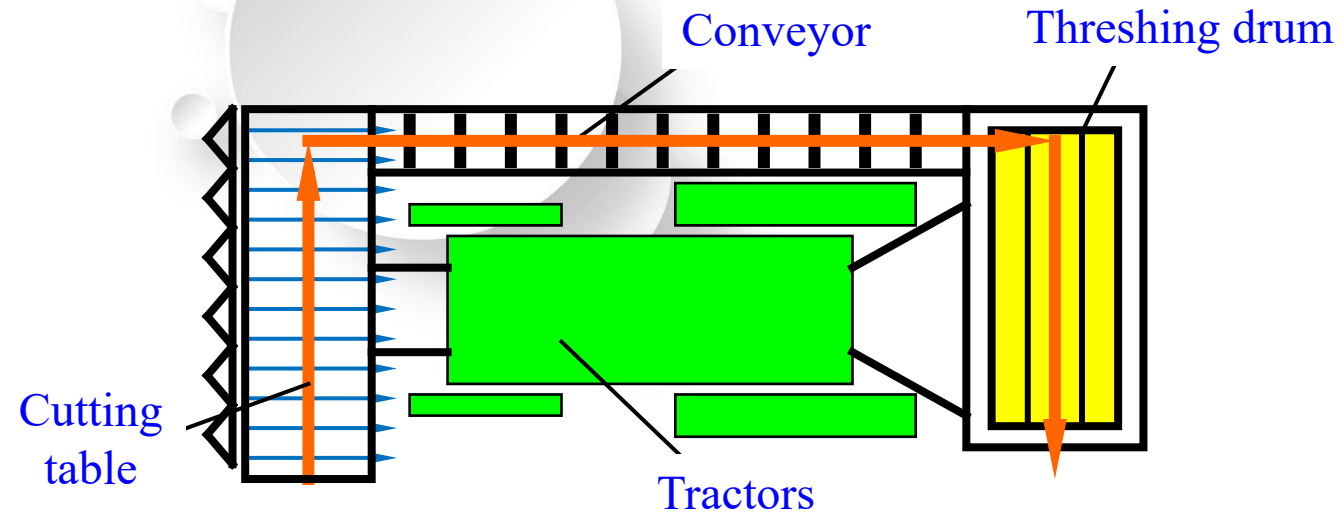
Self-propelled-comes with its own engine and walking device, opens the road by itself, good maneuverability, high productivity. However, the mechanism is complex, the cost is high, and the power utilization rate is low.



Classification of grain combine harvesters

2. Classification by power supply method: Tractor, self-propelled, Hanging

(3) Hanging harvester



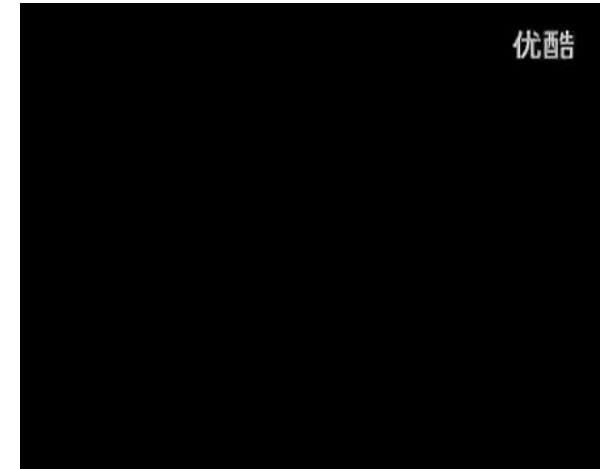
Suspended - the combine harvester is suspended from the tractor, the cutting deck is located in front of the tractor, the threshing device is located at the rear of the tractor, and the intermediate conveyor is connected to the side of the tractor. Good maneuverability, self-opening cutting path, low cost, high power utilization, but the overall configuration is limited by the tractor, the driver's field of vision is poor, the intermediate conveyor is long, the variable speed gears can not adequately meet the harvesting requirements, and the combine harvester subcomponents are suspended from the tractor, the overall poorer

Classification of rice combine harvesters

3. Classification by other methods:

- ◆ Cutting width (feed kg/s): large, medium, small
- ◆ Traveling parts: wheeled, tracked, half-tracked
- ◆ Crop types: wheat, rice, corn, soybeans

◆ Header feed combine





Head feed combine



Whole feed combine



Wheel combine



Tracklayer combine

Gushen4LZ-6 Grain Combine of LOVOL



This combine has portrait axial flow thresher with front lower and back high, the front of thresher linked with feeding device, the threshing board and knead pole were fixed cylinder.

Japanese header feed combine



Header feed combine has good adaptability, high efficiency, lower loss and high reliability.

Main performance:
Total losses < 2.5%
Breakup rate < 0.5%,
impurity rate < 1%,
reliability > 95%

Two kinds of typical rice combine



Whole feed combine



Head feed combine

Rice combine harvester



With combine harvester, the cutting, threshing, separating and cleaning work can be finished at one time.

Characteristic: high productivity, working periods short, losses small, high quality operation. The machine utilization rate lower, with high technology.

JOHN DEERE 3316 Grain Combine



With the most advanced technology (CTS)- applying the tangent-flow thresh cylinder and single axial with nail tooth.

This combine has high performance of thresh, separating. At same time, it has lower breakup rate.



Thank You!



The project is funded by **Bill and Melinda Gates Foundation.**